FEM 1.209:250230

COMPLETED

90

FLOOD INSURANCE STUDY

ORIGINAL

TOWN OF NANTUCKET, MASSACHUSETTS
NANTUCKET COUNTY

JUNE 3, 1986

Federal Emergency Management Agency

COMMUNITY NUMBER - 250230

cmlb

BEST COPY AVAILABLE

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
	1.1 Purpose of Study	1
	1.2 Authority and Acknowledgments	1
	1.3 Coordination	1
2.0	AREA STUDIED	2
	2.1 Scope of Study	2
	2.2 Community Description	2
	2.3 Principal Flood Problems	4
	2.4 Flood Protection Measures	5
3.0	ENGINEERING METHODS	6
	3.1 Hydrologic Analyses	6
	3.2 Hydraulic Analyses	9
4.0	FLOOD PLAIN MANAGEMENT APPLICATIONS	12
	4.1 Flood Boundaries	12
5.0	INSURANCE APPLICATION	13
	5.1 Reach Determinations	13
	5.2 Flood Hazard Factors	14
	5.3 Flood Insurance Zones	15
	5.4 Flood Insurance Rate Map Description	16

BEST COPY AVAILABLE

TABLE OF CONTENTS - continued

	Page
6.0 OTHER STUDIES	16
7.0 LOCATION OF DATA	16
8.0 BIBLIOGRAPHY AND REFERENCES	16

FIGURES

Figure 1 - Vicinity Map	3
Figure 2 - Transect Location Map	11

TABLES

Table 1 - High-Water Mark Elevations	7 - 8
Table 2 - Summary of Stillwater Elevations	8
Table 3 - Flood Insurance Zone Data	13 - 14

EXHIBITS

Exhibit 1 - Coastal Profiles
Transects 1 - 59 Panels 01C - 33C

Exhibit 2 - Flood Insurance Rate Map Index
Flood Insurance Rate Map

BEST COPY AVAILABLE

FLOOD INSURANCE STUDY
TOWN OF NANTUCKET, MASSACHUSETTS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Town of Nantucket, Nantucket County, Massachusetts, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by PRC Harris for the Federal Emergency Management Agency (FEMA), under Contract No. H-4776 (completed in August 1980) and under Contract Modification No. M010. This study was completed in July 1983.

1.3 Coordination

On April 7, 1978, an initial Consultation and Coordination Officer's (CCO) meeting, attended by representatives of the Town of Nantucket, FEMA, and PRC Harris (the study contractor), was held to identify the scope of study and to explain the technical aspects of the study.

Contact with the town was maintained throughout the study to discuss historical flooding and flood plain development patterns. The Massachusetts Department of Commerce and Development, the U. S. Department of

BEST COPY AVAILABLE

Housing and Urban Development, the U. S. Geological Survey (USGS), Schofield Brothers, Lockwood Mapping, Andrew Gutman, and Michael Bachman were contacted for various types of information. The National Ocean Survey furnished tide tables for the gages at Montauk, New York; Newport, Rhode Island; and Nantucket, Massachusetts.

An intermediate CCO meeting was held on September 19, 1983, to review the study progress. On February 4, 1985, the results of the study were reviewed at a final CCO meeting held with representatives of FEMA, the town, and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Town of Nantucket, Nantucket County, Massachusetts. The area of study is shown on the Vicinity Map (Figure 1).

Tidal flooding including its wave action from the Atlantic Ocean and Nantucket Sound was studied by detailed methods. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction through July 1988.

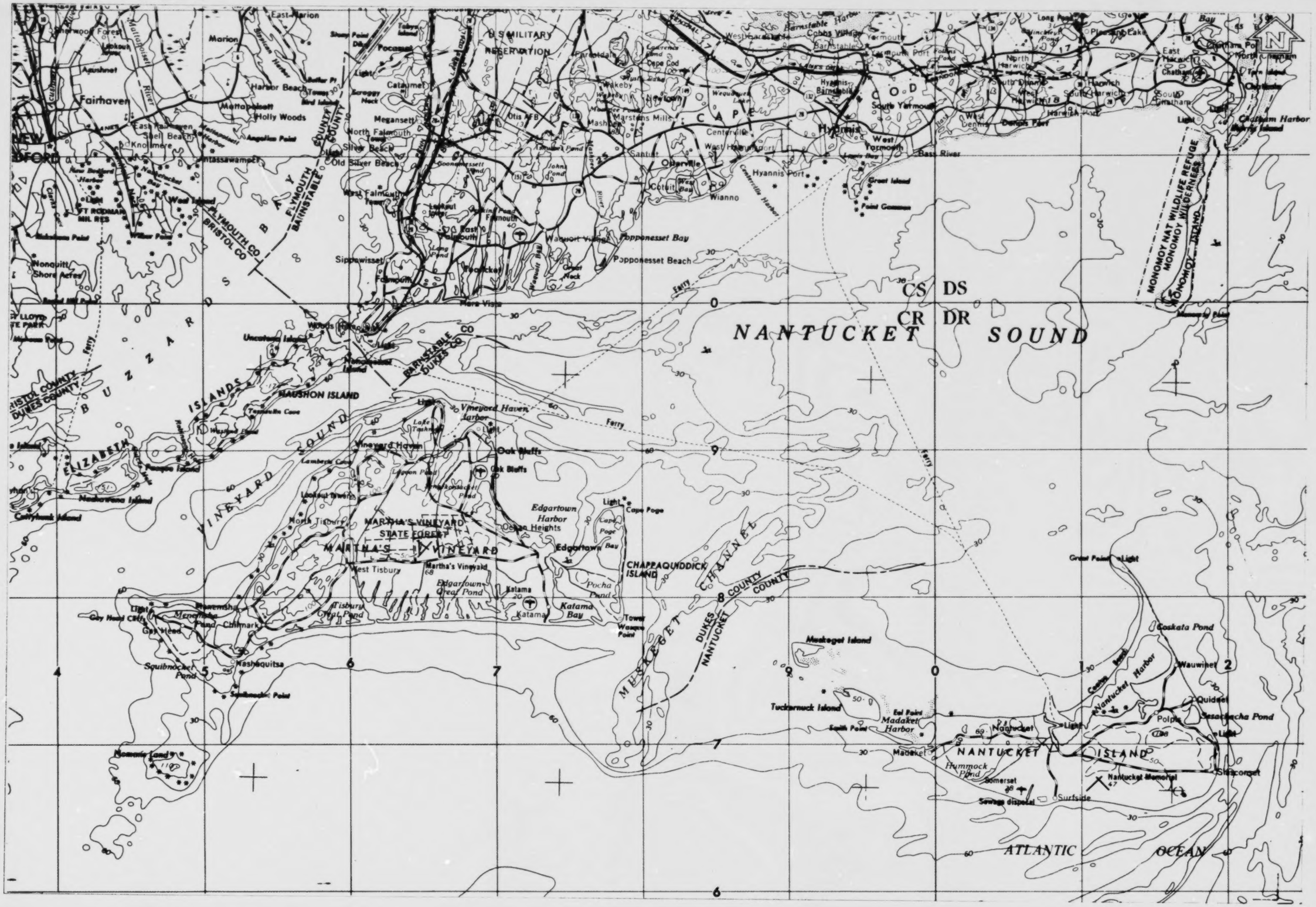
The following flooding sources were studied by approximate methods: Phillips Run, Tom Nevers Pond, Gibbs Pond, and the cranberry bog west of Sesachacha Pond. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the Town of Nantucket.

2.2 Community Description

The Town of Nantucket is an island community located directly south of Cape Cod, Massachusetts. It is bordered by Nantucket Sound to the north, the Atlantic Ocean to the south and east, and Madeket Harbor to the west. The town includes not only the island of Nantucket, but also Muskegat, Tuckernuck, and Esther Islands, and seven unnamed islands.

Encompassing an area of 49.5 square miles, the main island of Nantucket measures approximately 15 miles from east to west and 10 miles from north to south. The year round population was 3,774 in 1970; however, this population increases to almost 30,000 in the summer. Originally the center of the whaling trade, Nantucket has shifted its economy to tourism and other industries, including construction, fishing, and agriculture.

ST COPY AVAILABLE



APPROXIMATE SCALE
0 4 8 12 MILES

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

VICINITY MAP

FIGURE 1

BEST COPY AVAILABLE

The nature of flood plain development has been described in the Nantucket Shoreline Survey:

> Seasonal or short term visitors to Nantucket swell the off-season population from about 6,000 to 30,000. They are drawn to the island by the historical buildings, museums, and wide ranging coastal recreational opportunities along nearly 100 miles of spectacular, unspoiled sandy beaches, dunes, and bluffs. Many people who come as visitors decide to buy coastline property and build homes. Increasing coastal development over the years has led to some serious management and land use problems primarily because much of Nantucket's shoreline is subject to severe storm damage, flooding, and erosion (Reference 1).

Many low-lying areas have been developed since the time of the last damaging storms of 1939, 1954, and 1971. These areas included Madeket and Low Beach at Siaskonset. Most of the buildings are seasonal residences with sites chosen during the summer months when the ocean is relatively calm.

The climate of Nantucket is moderate, with temperatures ranging from a mean of 32.5 degrees Fahrenheit (°F) in January to a mean of 67.5°F in July. Average annual precipitation is 43.66 inches (Reference 2).

Nantucket was formed approximately 50,000 years ago as the continental ice sheets deposited great piles of conglomerate soils at their terminus. These moraine deposits now form the islands of Martha's Vineyard and Nantucket, the Elizabeth Islands, and Cape Cod. The resulting soils of Nantucket are mixed and sandy, with wet soils in the northeast. The terrain of the area is irregular, consisting of large expanses of low, flat land in the south and southwest, and hills in the central section rising to almost 100 feet.

2.3 Principal Flood Problems

Nantucket is subject to coastal flooding caused by northeasters and hurricanes. Northeasters can occur at any time of the year but are more prevalent in the winter months. Hurricanes occur in the late summer and early fall months.

A hurricane develops as a tropical storm either near the Cape Verde Islands off the African coast or in the western Caribbean Sea. Most hurricanes that reach Nantucket approach from a southern direction after recurving east of Florida and skirting the mid-Atlantic states. These hurricanes start their journey with a forward speed of approximately 10

BEST COPY AVAILABLE

miles per hour. After recurving towards Long Island, they may increase their speed to 20 to 30 miles per hour up to 60 miles per hour as they approach the colder water temperatures found in the northern latitudes.

The most destructive hurricane winds occur east of the eye where the spiral wind movement and forward montion of a storm combine. For this reason, the actual track of the hurricane is very important because of the effect its high wind velocity may have on the community. Tidal levels along the coastline are greatly influenced by the force, duration, and direction of these winds, as well as the distance or fetch across open water over which the winds act.

A northeaster travels in a southwest to northeast direction along the Atlantic coast, collecting moisture over the ocean and sending it inland via northeast winds. Northeasters differ from hurricanes in that they cover a larger area, are not as intense, move more slowly, and have a longer duration. While a hurricane may last for several hours, a northeaster may last for several days; therefore, northeasters are usually accompanied by at least one high tide, increasing the severity of coastal flooding. These high levels result from a drop in the barometric pressure and from strong winds which can blow out of the northeast across the considerable fetch of the Atlantic Ocean.

Erosion is the primary problem from storms in Nantucket. The shoreline is constantly changing, as documented in the Nantucket Shoreline Survey (Reference 1). Erosion rates are high on the south and east shores, where storm waves are greatest, and they are less significant on the north shore where storm waves are less severe but damaging. The effects of wave action and erosion are most significant where fetches are longest and offshore water depth is greatest, such as at the south and east shores. The areas of Cod Fish Park and the Naval Station on the south shore were identified as having severe erosion through comparison of the Nantucket town maps and aerial photos taken in the fall of 1982.

2.4 Flood Protection Measures

The Town of Nantucket does not have a comprehensive flood plain zoning ordinance. Some flood plain areas are protected within conservation districts which include wetlands, woodlands, and wildlife protection (Reference 3). Structural flood protection measures have been constructed in several areas, primarily for protection against wave action. Nantucket Harbor and Madaket Harbor are protected against large ocean waves by the east and west jetties, respectively. A number of shorefront houses are afforded protection by small seawalls or breakwaters.

BEST COPY AVAILABLE

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Analyses were carried out to establish the peak elevation-frequency relationships for each flooding source studied in detail affecting the community.

Elevation-frequency relationships for Martha's Vineyard, Nantucket Island, the southern coast of Rhode Island, and Block Island have been determined through a Pearson Type III analysis on the tide gages at Montauk (29 years of record) and at Newport (44 years of record). These analyses show that the storm of August 1954 has an estimated 100-year recurrence interval.

The stillwater elevations for Nantucket were determined from a two-dimensional storm surge model, used to numerically simulate northeasters (References 4, 5, 6, and 7). This model was a modification of the model in the report Coastal Flooding Storm Surge Model (Reference 8). An option was added to model hurricanes, because Nantucket's peak flood levels are caused by both types of storms.

The initial portion of the model is a simulation of meteorological conditions associated with storms. Two types of storms can be modeled, either northeasters or hurricanes. For Nantucket, both types of storms were modeled based on storm radius, central pressure depression, storm track, and forward speed. The differences in the two storms are in wind field definition and storm shape.

BEST COPY AVAILABLE

Fifteen historic storms were modeled from synoptic charts (Reference 9). The model output consists of pressure and wind fields for the storm and arrays of the resulting wind stress and barometric rise of the water surface.

The wind stress and barometric rise arrays were saved for input to the second portion of the model, which consisted of a simulation of the physical characteristics of the study area. For the coasts of Nantucket, the entire Nantucket, Rhode Island, and Block Island Sounds were modeled. Input consisted of the arrays specified by the northeaster and hurricane models and a two-dimensional grid system to define the study area, where depths were specified for every grid point, and land areas were defined. The model utilized an explicit, finite difference numerical scheme to solve the basic momentum equations in two dimensions. The output is a time series of storm surge elevations for every grid point. These elevations were combined with predicted astronomical tide data to produce the total stillwater elevations.

Fourteen other storms were run, and the model results were compared to recorded elevations at the Montauk and Newport tide gages. For each storm, ratios were developed to compare the elevation at each coastal point to the elevation at each of the gages. A single ratio for each point was developed based on all storm models to relate tidal flooding at the point to tidal flooding at Newport and Montauk. These ratios were applied to the gage records to derive an elevation-frequency curve for the outer coast of Nantucket.

The model was calibrated with the August 1954 storm. Model surge elevations were compared to recorded elevations (References 10, 11, and 12). The model and recorded elevations showed good correlation. Historic high-water mark elevations for major floods in the Nantucket area are shown in Table 1. Also, the northeaster of March 16-17, 1956, had an elevation of 5.2-6.2 feet at Nantucket Harbor.

TABLE 1 - HIGH-WATER MARK ELEVATIONS

Date	Storm Type	Montauk Gage (In feet)	Newport Gage (In feet)	Nantucket Gage (In feet)
April 20-22, 1940	Northeaster	*	7.2	*
November 30, 1944	Northeaster	*	8.6	*
August 21, 1954	Hurricane	12.3	12.5	*
March 8-9, 1957	Northeaster	7.4	6.7	*
December 29-30, 1959	Northeaster	8.4	7.8	*
March 3-5, 1960	Northeaster	7.8	6.5	*
January 19-21, 1961	Northeaster	*	7.7	*

*No record available.

BEST COPY AVAILABLE

TABLE 1 - HIGH-WATER MARK ELEVATIONS - continued

Date	Storm Type	Montauk Gage (In feet)	Newport Gage (In feet)	Nantucket Gage (In feet)
March 9, 1961	Northeaster	8.6	6.8	*
January 23-24, 1966	Northeaster	7.5	7.3	3.3
December 3-5, 1967	Northeaster	*	7.2	*
February 8, 1968	Northeaster	*	6.0	*
November 10-12, 1968	Northeaster	9.7	7.6	4.1
February 19, 1972	Northeaster	9.6	8.6	4.2
March 16-18, 1976	Northeaster	8.4	*	*
February 6-7, 1978	Northeaster	10.6	9.0	*

*No record available.

The stillwater elevations for the 10-, 50-, 100-, and 500-year floods have been determined for the flooding sources studied in detail and are summarized in Table 2.

TABLE 2 - SUMMARY OF STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
ATLANTIC OCEAN				
South and west shorelines	4.8	6.2	7.2	9.5
NANTUCKET SOUND				
Madaket Harbor, Nantucket Harbor, and north shorelines	5.0	6.5	7.5	10.0

The analyses reported in this study reflect the stillwater elevations due to tidal and wind setup effects. The effects of wave action were also considered in the determination of flood hazard areas. Coastal structures that are located above stillwater flood elevations can still be severely damaged by wave runup, wave-induced erosion, and wave-borne debris. For example, during the northeasters of January and February 1978, considerable damage along the Massachusetts coast was caused by wave activity, even though most of the damaged structures were above the high-water level. The extent of wave runup past stillwater levels depends greatly on the wave conditions and local topography.

BEST COPY AVAILABLE

Wave heights and corresponding wave crest elevations were determined using the National Academy of Sciences (NAS) methodology (Reference 13). The wave runup was determined using the methodology developed by Stone and Webster Engineering Corporation for FEMA (Reference 14).

3.2 Hydraulic Analyses

Hydraulic analyses, considering storm characteristics and the shoreline and bathymetric characteristics of the flooding sources studied, were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of the shorelines.

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The COE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones (Reference 15). The 3-foot wave has been determined as the minimum size wave capable of causing major damage to conventional wood frame or brick veneer structures.

A wave height analysis was performed to determine wave heights and corresponding wave crest elevations for the areas inundated by the tidal flooding. A wave runup analysis was performed to determine the height and extent of runup beyond the limit of tidal inundation. The results of these analyses were combined into a wave envelope, which was constructed by extending the maximum wave runup elevation seaward to its intersection with the wave crest profile.

The methodology for analyzing wave heights and corresponding wave crest elevations was developed by the NAS (Reference 13). The NAS methodology is based on three major concepts.

First, a storm surge on the open coast is accompanied by waves. The maximum height of these waves is related to the depth of water by the following equation:

$$H_b = 0.78d$$

where H_b is the crest to trough height of the maximum or breaking wave and d is the stillwater depth. The elevation of the crest of an unimpeded wave is determined using the equation:

$$Z_w = S_* + 0.7H_* = S_* + 0.55d$$

where Z_w is the wave crest elevation, S_* is the stillwater elevation at the site, and H_* is the wave height at the site. The 0.7 coefficient is the portion of the wave height which reaches above the stillwater elevation. H_b is the upper limit for H_*.

BEST COPY AVAILABLE

The second major concept is that the breaking wave height may be diminished by dissipation of energy by natural or man-made obstructions. The wave height transmitted past a given obstruction is determined by the following equation:

$$H_t = BH_i$$

where H_t is the transmitted wave height, H_i is the incident wave height, and B is a transmission coefficient ranging from 0.0 to 1.0. The coefficient is a function of the physical characteristics of the obstruction. Equations have been developed by the NAS to determine B for vegetation, buildings, natural barriers such as dunes, and man-made barriers such as breakwaters and seawalls (Reference 13).

The third concept deals with unimpeded reaches between obstructions. New wave generation can result from wind action. This added energy is related to distance and mean depth over the unimpeded reach.

The methodology for analyzing wave runup was developed by Stone and Webster Engineering Corporation (Reference 14). The wave runup computer program operates using an ensemble of deepwater wave heights, H_i, the stillwater elevation, S*, a wave period, T_s, and beach slope, m. For Nantucket, wave heights range from 3 feet up to the significant wave height of 19 feet; the wave period ranges from 3.0 to 12.5 seconds.

These concepts and equations were used to compute wave envelope elevations associated with the 100-year storm surge. Accurate topographic, land-use, and land cover data are required for the coastal analyses. Maps of the study area, at a scale of 1:2,400 with a contour interval of 5 feet were used for the topographic data (Reference 16). Depths below mean low water were determined from NOS nautical charts (Reference 17). The land-use and land cover data were obtained by field surveys and aerial photographs (Reference 18).

Wave heights and wave runup were computed along transects which were located perpendicular to the average mean shoreline. The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, the transects were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects. Figure 2, "Transect Location Map," illustrates the location of the transects for the community.

Along each transect, wave envelope elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. Between transects, elevations were interpolated using

BEST COPY AVAILABLE

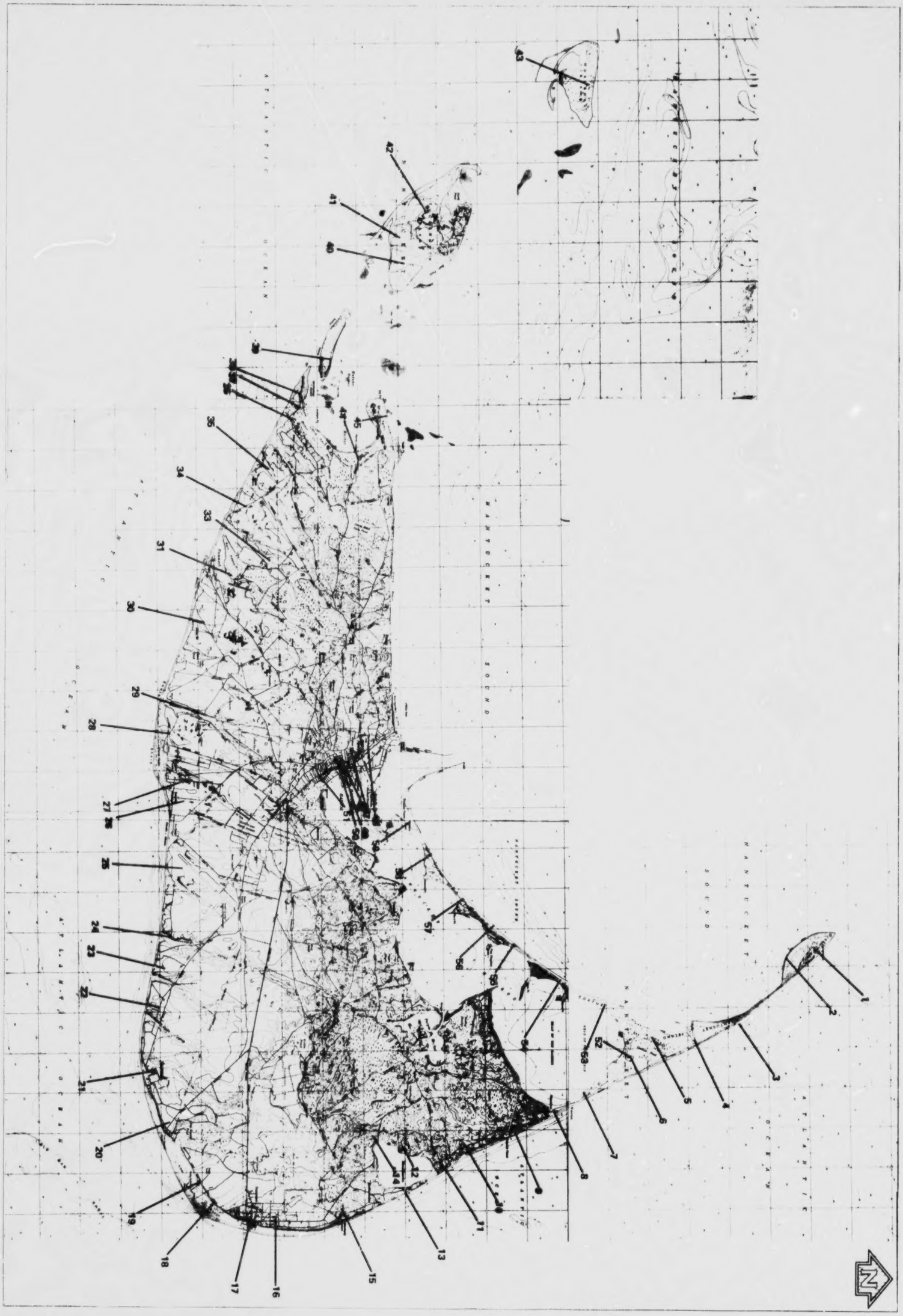


FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

APPROXIMATE SCALE

7600 0 7600 15,200 22,800 FEET

TRANSECT LOCATION MAP

BEST COPY AVAILABLE

the topographic maps, land-use and land cover data, and engineering judgment to determine the areal extent of flooding. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergo any major changes. Selected beach transects with stillwater elevations for the 10- and 100-year recurrence intervals and wave envelope profiles for the 100-year recurrence interval are shown on the Coastal Profiles (Exhibit 1).

Areas of shallow flooding have been determined for the lee side of the dunes along the Atlantic Ocean, Nantucket Sound, Madaket Harbor, and Nantucket Harbor. In these areas, the wave runup elevation exceeded the dune crest elevation. The difference between the runup elevation and the dune crest was used to determine the depth of shallow flooding behind the dune (Reference 19).

Wave crest and runup calculations were not performed on Nantucket Sound and on the the north facing coast of Nantucket Harbor, because the peak storm surge elevation and peak hurricane winds will not occur simultaneously in this region.

All elevations used in this study are referenced to the Half Tide Level (HTL) Datum of Nantucket Island. This datum is mean low water of 1934. In 1939, all existing bench marks in Nantucket were tied into HTL by the Massachusetts Department of Public Works. The National Geodetic Vertical Datum of 1929 (NGVD) has never been established in Nantucket. Elevation reference marks used are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For tidal areas without wave action, the 100-year and 500-year boundaries were delineated using topographic maps at a scale of 1:2,400 with a contour interval of 5 feet (Reference 16). For the tidal areas with wave action, the flood boundaries were delineated using the elevations determined at each transect; between transects, the boundaries were interpolated using engineering judgment, land-cover data, and the topographic maps referenced above. The 100-year flood plain was divided into whole-foot elevation zones based on the average wave

BEST COPY AVAILABLE

envelope elevation in that zone. Where the map scale did not permit these zones to be delineated at one foot intervals, larger increments were used.

The approximate studied areas were delineated using the Flood Hazard Boundary Map for the Town of Nantucket (Reference 20). For the areas studied by approximate methods, only the 100-year flood plain boundary is shown.

The 100- and 500-year flood plain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for the flooding sources studied in detail in the Town of Nantucket.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard. In areas where wave height and wave runup analyses were performed, reaches were determined for areas of the coastline, represented by a transect or group of transects, which have the same physical characteristics. For each transect the coastal high hazard zone (V zone) may be divided into two reaches to reflect those areas where wave runup is a dominant factor and those areas where wave runup does not dominate and elevations are determined by the wave height analysis. The reaches determined for the Town of Nantucket are summarized in Table 3.

TABLE 3 - FLOOD INSURANCE ZONE DATA

Flooding Source	Stillwater Elevation 10-Year	Stillwater Elevation 100-Year	FHF	Zone	Base Flood Elevation (Feet HTL)*
Atlantic Ocean	4.8	7.2	025	V5	9-23
			035	V7	9-11
			035	A7	7-9
			030	A6	7-9
			025	A5	7-20

BEST COPY AVAILABLE

TABLE 3 - FLOOD INSURANCE ZONE DATA - continued

Flooding Source	Stillwater Elevation 10-Year	Stillwater Elevation 100-Year	FHF	Zone	Base Flood Elevation (Feet HTL)*
Atlantic Ocean (continued)					
	Shallow Flooding - Average Depth 1.0 and 2.0 Feet			A0	--
	Shallow Flooding			AH	7
	Shallow Flooding			AH	8
	Shallow Flooding			AH	9
	Shallow Flooding			AH	10
	Shallow Flooding			AH	11
	Shallow Flooding			AH	13
Nantucket Sound	5.0	7.5	025	V5	9-11
			040	V8	10
			040	A8	8-10
			035	A7	8-10
			030	A6	8-10
			025	A5	8
	Shallow Flooding - Average Depth 1.0 and 2.0 Feet			A0	--

*Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

BEST COPY AVAILABLE

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zone AO:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; depths are shown but no FHFs are determined.
Zone AH:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; base flood elevations are shown, but no FHFs are determined.
Zones A5, A6, A7, and A8:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.
Zones V5, V7, and V8:	Special Flood Hazard Areas along coasts inundated by the 100-year flood that have additional velocity hazards associated with waves of 3-foot amplitude or greater; with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the community are shown in Table 3.

BEST COPY AVAILABLE

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Town of Nantucket is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

Nantucket Shoreline Survey is a study of erosion in Nantucket (Reference 1). This study does not consider erosion for purposes of flood insurance; however, this study is relative to flood plain management.

The Tidal Flood Profiles, New England Coastline, gives a 100-year stillwater elevation for Nantucket's north shore (Reference 12). This elevation does not agree with the elevation in this study due to the more detailed and site specific nature of the hydrologic analyses used for this study.

Due to its more detailed nature, this Flood Insurance Study supersedes the Flood Hazard Boundary Map for the Town of Nantucket (Reference 20).

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Regional Director, Region I Office, J. W. McCormack Post Office and Courthouse Building, Room 462, Boston, Massachusetts 02109.

8.0 BIBLIOGRAPHY AND REFERENCES

1. MIT Sea Grant Program, University of Massachusetts Cooperative Extension Service, Nantucket Shoreline Survey, by Andrew L. Gutman, Michael Goetz, Francesca Brown, James Lentowski, Wesley Tiffney, Cambridge, Massachusetts, August 1979.

2. Commonwealth of Massachusetts, Department of Commerce and Development, Massachusetts Profile of Nantucket County and Town, Boston, Massachusetts, Undated.

BEST COPY AVAILABLE

3. Nantucket Planning and Economic Development Commission, Natural Resources Planning Program, Present Land Use, Maps of District 1-15.2, Approximate Scale 1" = 1,800', Massachusetts, February 1977.

4. Stone and Webster Engineering Corporation, Development and Verification of a Synthetic Northeaster Model for Coastal Flood Analysis, Boston, Massachusetts, 1978.

5. Stone & Webster Engineering Corporation, Appendix A, Two-Dimensional Storm Surge Program (Draft), Boston, Massachusetts, 1978.

6. Stone & Webster Engineering Corporation, Computer Program, Storm Surge, Boston, Massachusetts, October 1978.

7. Stone & Webster Engineering Corporation, Computer Program, Northeaster Model, Boston, Massachusetts, October 1978.

8. Tetra Tech, Inc., Coastal Flooding Storm Surge Model, Parts I and II, Pasadena, California, May 1978.

9. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Environmental Data Service, Synoptic Weather Charts, Published 1931, 1940, 1944, 1950, 1953, 1954, 1957, 1958, 1959, 1960, 1961, 1962, 1966, 1967, 1968, 1969, 1972, 1976, and 1978.

10. U. S. Army Corps of Engineers, New England Division, Annual Peak Tide Levels, Newport, Rhode Island, 44 Years of Record, 1931-1975, Waltham, Massahusetts.

11. U. S. Army Corps of Engineers, New England Division, Annual Peak Tide Levels, Montauk Point, New York, 29 Years of Record, 1947-1975, Waltham, Massahusetts.

12. U. S. Army Corps of Engineers, New England Division, Tidal Flood Profiles, New England Coastline, Waltham, Massahusetts, January 1980.

13. National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated with Storm Surges, Washington, D. C., 1977.

14. Stone and Webster Engineering Corporation, Manual for Wave Runup Analysis, Coastal Flood Insurance Studies, Boston, Massachusetts, November 1981.

15. U. S. Army Corps of Engineers, Galveston District, Guidelines for Identifying Coastal High Hazard Zones, Galveston, Texas, June 1975.

BEST COPY AVAILABLE

16. Schofield Brothers, Inc., of Nantucket, Massachusetts; and Lockwood Mapping, Inc., of Rochester, New York; Topographic Maps compiled from photogrammetric mapping, Scale 1:2,400, Contour Interval 5 Feet: Town and County of Nantucket, 1975.

17. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Navigational Charts, Scale 1:80,000: No. 130006, West Quoddy to New York; No. 13217, Tidal Block Island; No. 13233, Martha's Vineyard; No. 13241, Nantucket; Asheville, North Carolina, 1969.

18. Geod Surveying and Aerial Mapping Corporation of Oak Ridge, New Jersey, Topographic maps compiled from aerial photographs, Scale 1" = 1600': Town of Nantucket, Massachusetts, 1982.

19. P. Williams, Interoffice Correspondence on "Wave Runup Methodology, Massachusetts and Rhode Island Flood Insurance Study," PRC Harris, April 7, 1983.

20. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Town of Nantucket, Nantucket County, Massachusetts, December 3, 1976.

Harris-Toups Associates, Flood Insurance Study, Coastal Flooding Analysis, Boston, Massachusetts, Lake Success, New York, December 1977.

Ippen, Arthur T., Estuary and Coastline Hydrodynamics, New York, McGraw-Hill, 1966.

Town of Nantucket, Annual Report of the Town and County of Nantucket, Massachusetts, Massachusetts, 1977.

U. S. Army Corps of Engineers, Shore Protection Manual, Volumes I, II, and III, Washington, D. C., 1977.

U. S. Department of Commerce, Coast and Geodetic Survey, Tides, Monthly Means and Extremes, Nantucket, Massachusetts, 1965-1975, Washington, D. C.

U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Tide Table, 1931-1980, East Coast of North and South America, Washington, D. C., Published annually.

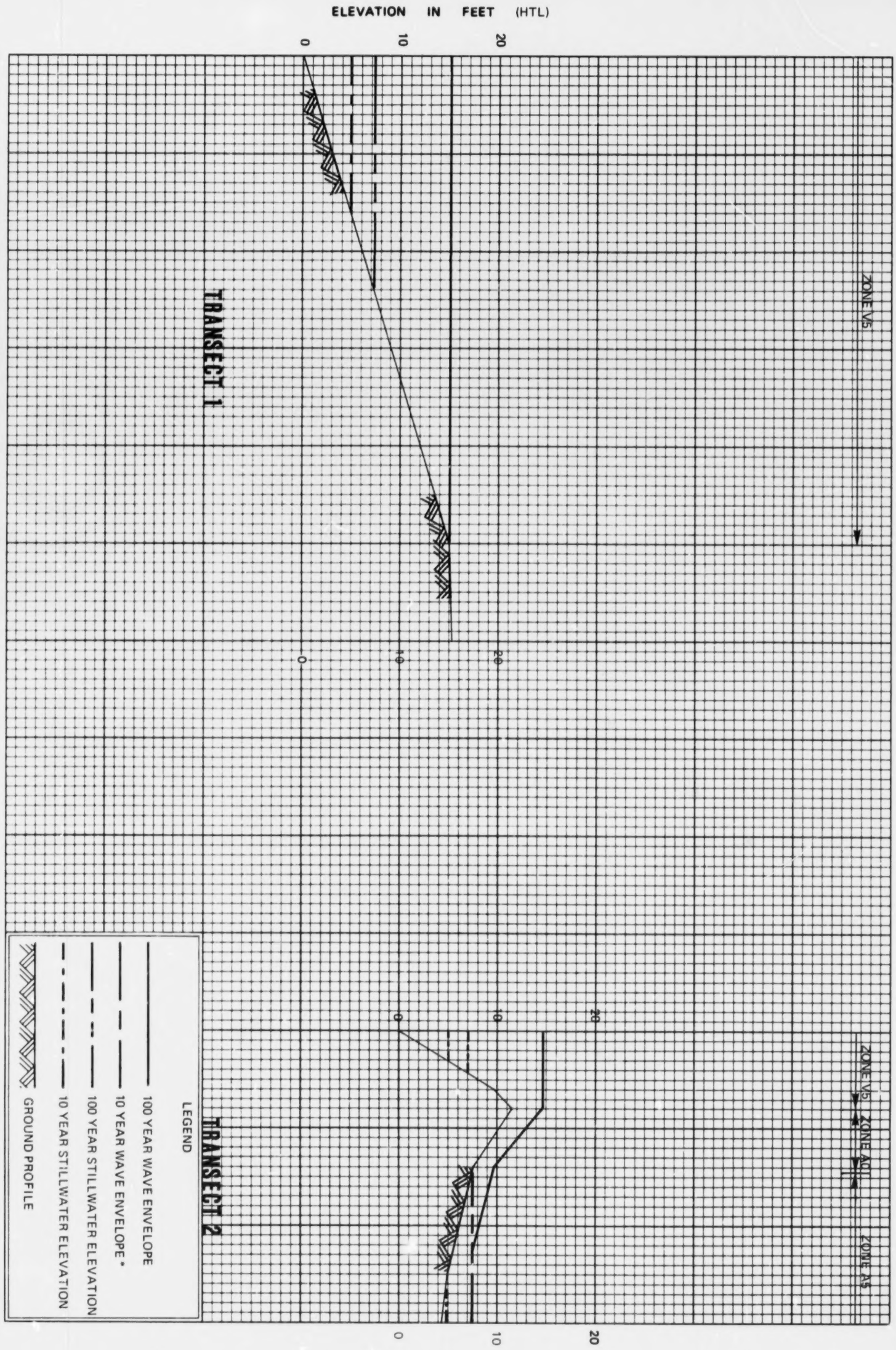
U. S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 10 Feet: Great Pond, Massachusetts, 1972; Nantucket, Massachusetts, 1972; Siasconset, Massachusetts, 1972; Tuckernuck Island, Massachusetts, 1972.

BEST COPY AVAILABLE

U. S. Department of the Interior, Hurricane Floods of September 1938, Washington, D. C., 1940.

Water Resources Council, "Guidelines for Determining Flood Flow Frequency," Bulletin 17, Washington, D. C., March 1976.

BEST COPY AVAILABLE



FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

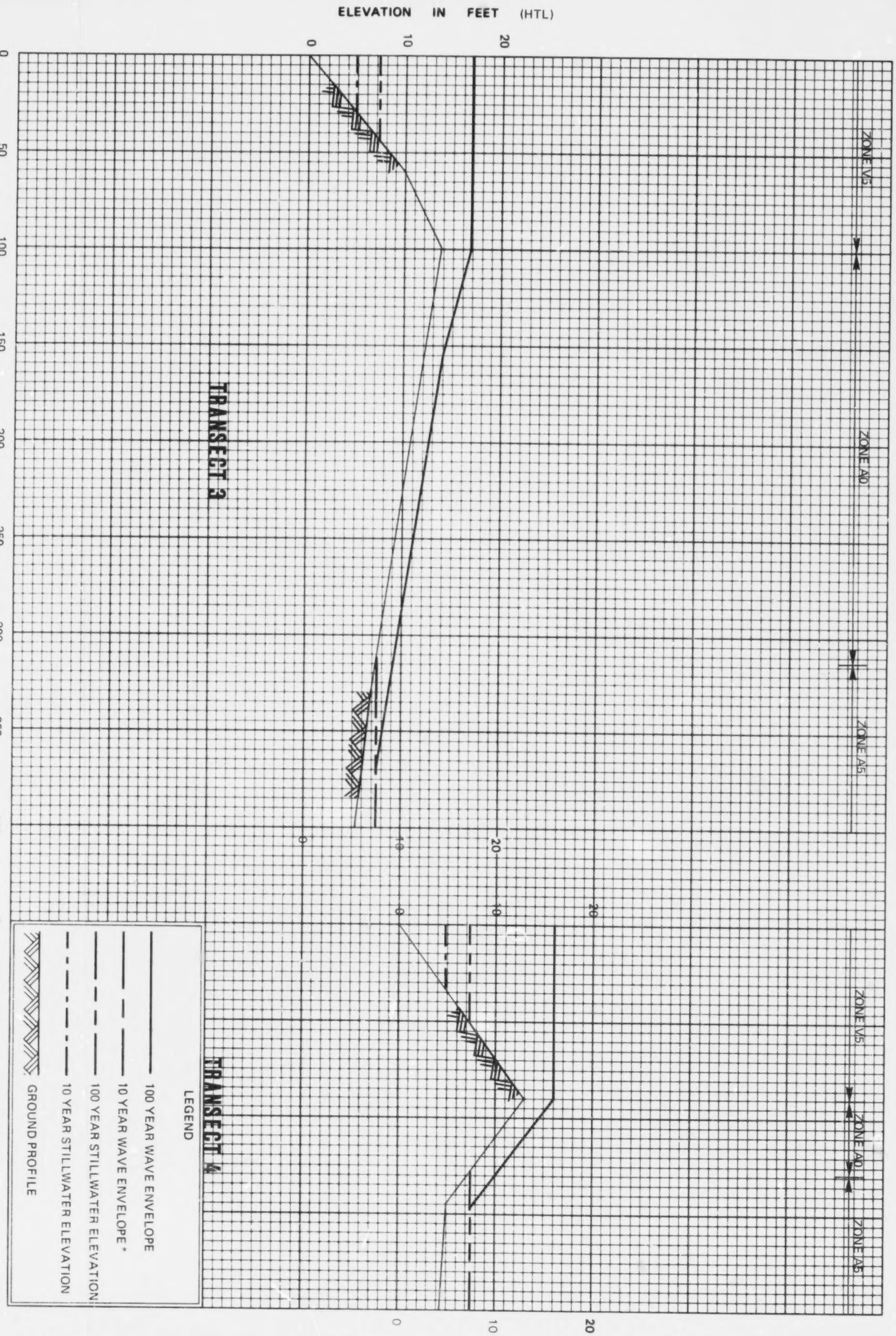
COASTAL PROFILES

TRANSECTS 1 AND 2

01C

20

BEST COPY AVAILABLE



FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

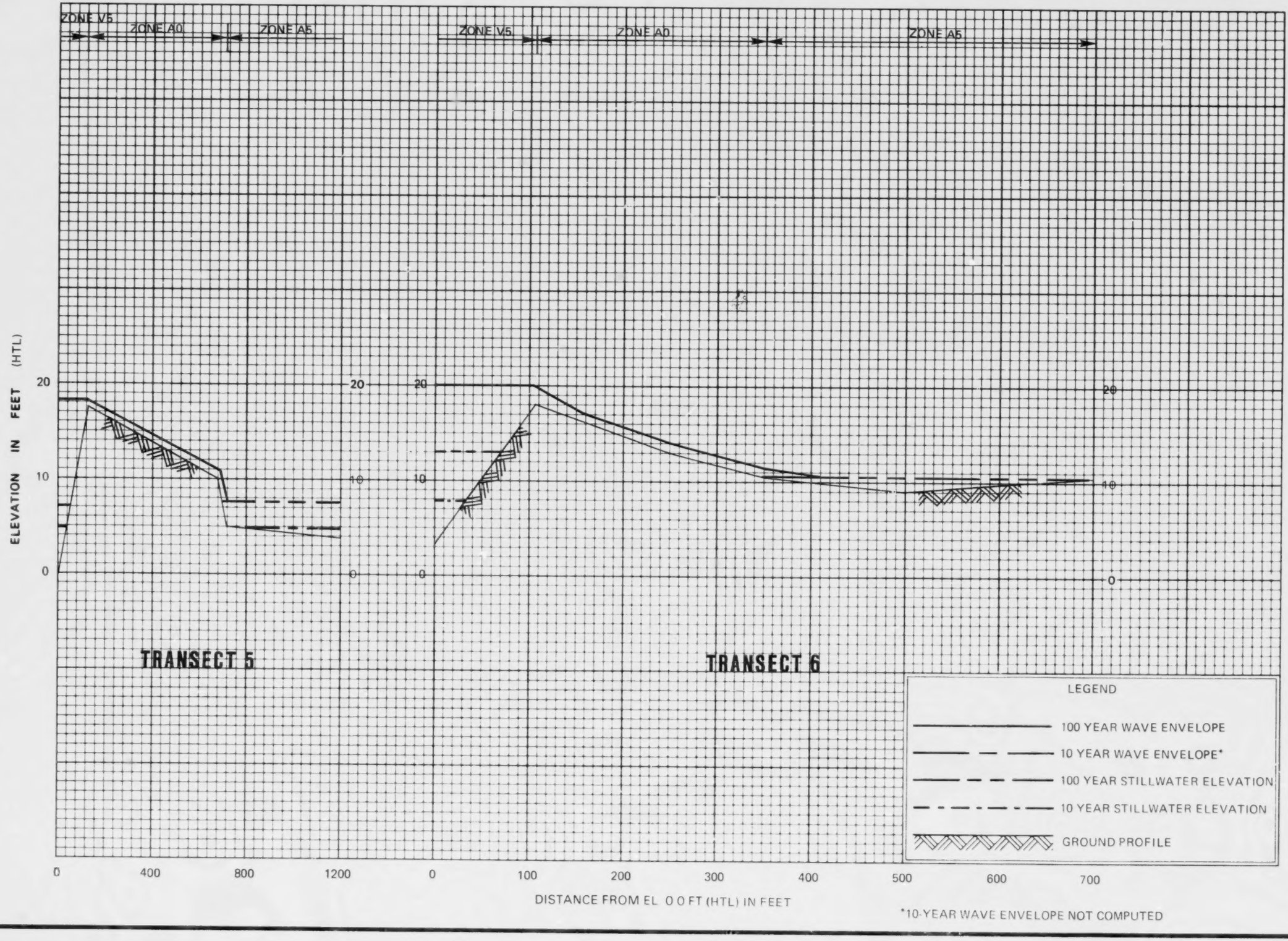
COASTAL PROFILES

TRANSECTS 3 AND 4

02C

21

BEST COPY AVAILABLE



*10-YEAR WAVE ENVELOPE NOT COMPUTED

COASTAL PROFILES

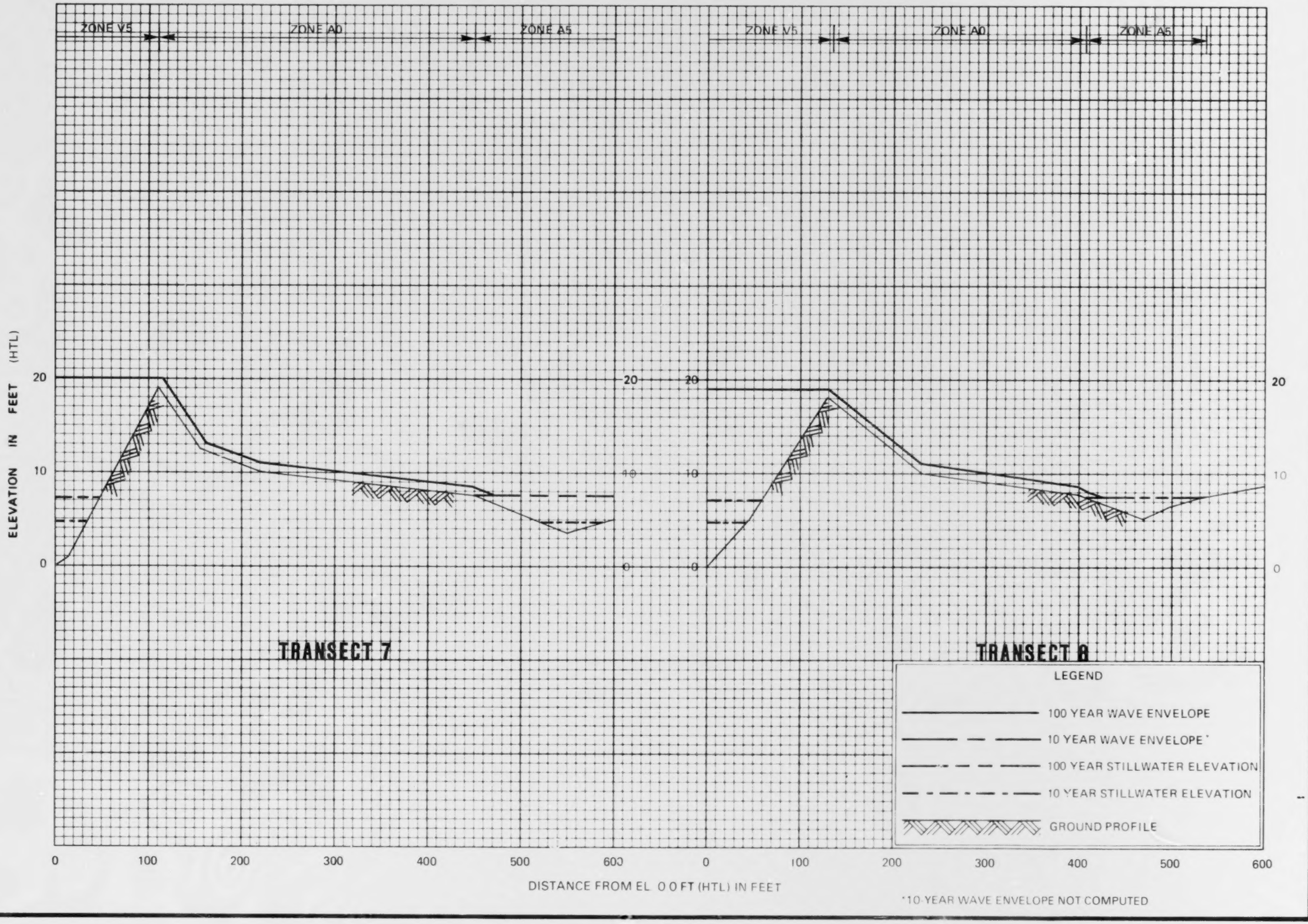
TRANSECTS 5 AND 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

03C

BEST COPY AVAILABLE



COASTAL PROFILES

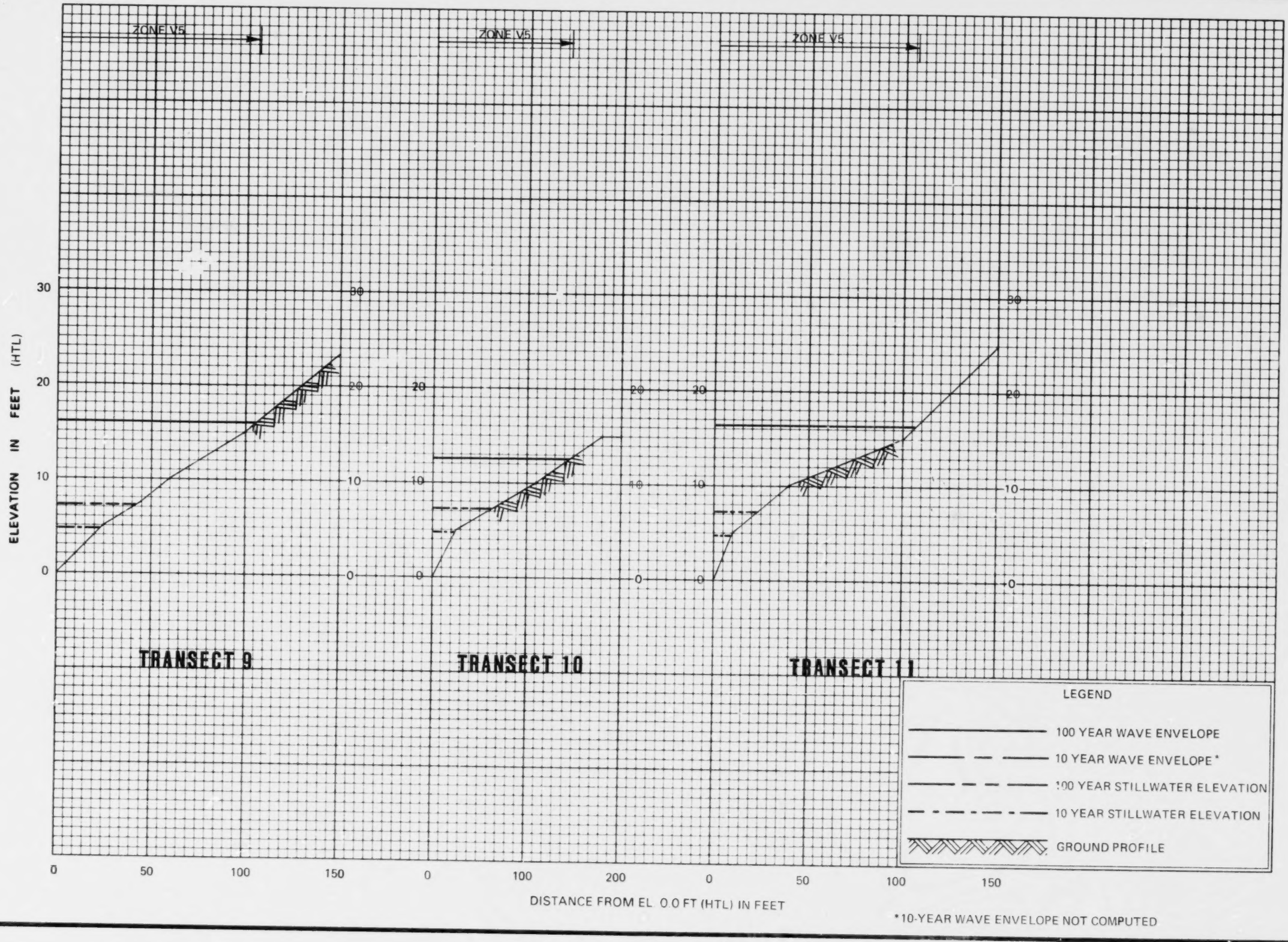
TRANSECTS 7 AND 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

04C

BEST COPY AVAILABLE



COASTAL PROFILES

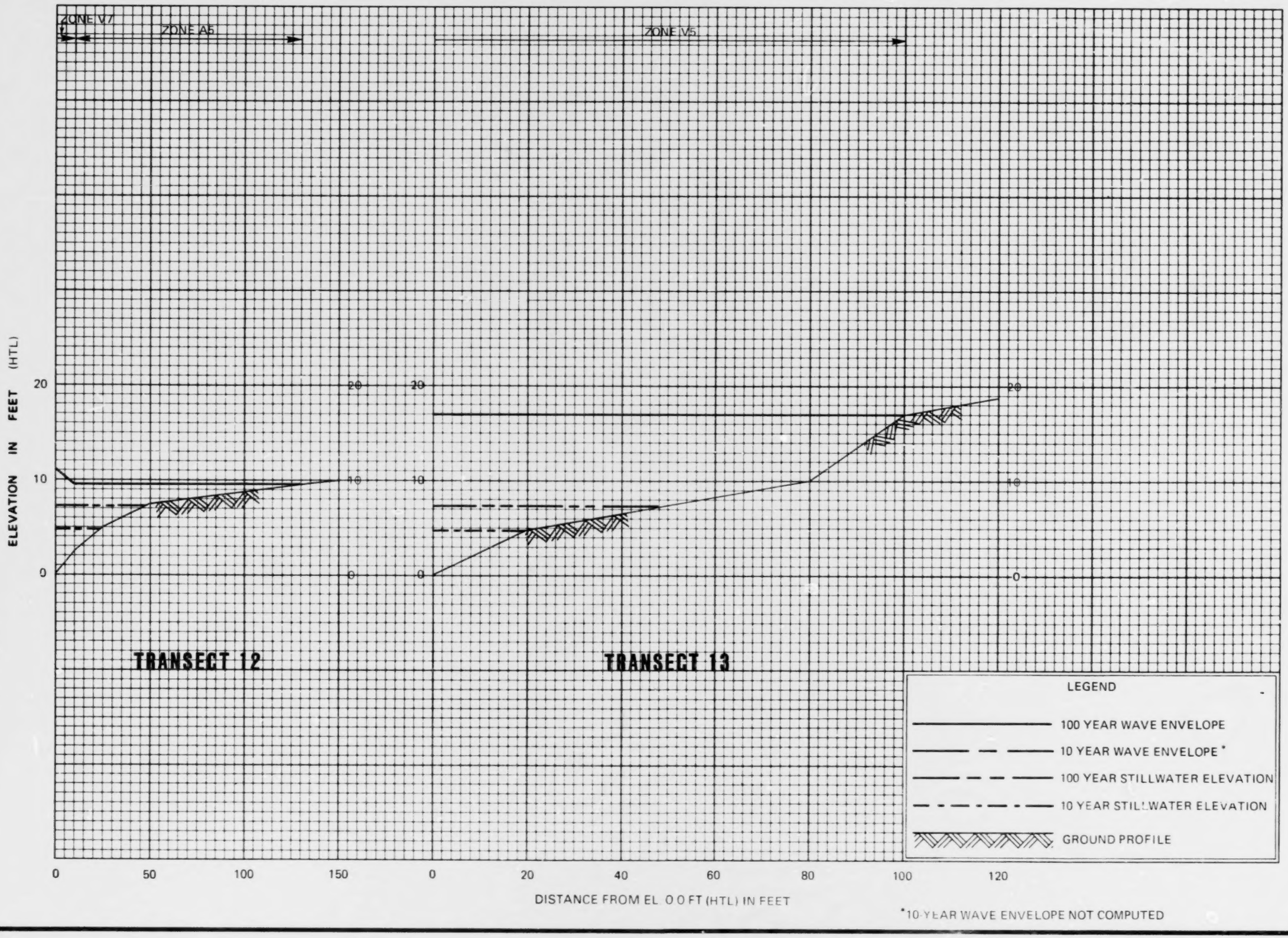
TRANSECTS 9,10,AND 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

05C

BEST COPY AVAILABLE



COASTAL PROFILES

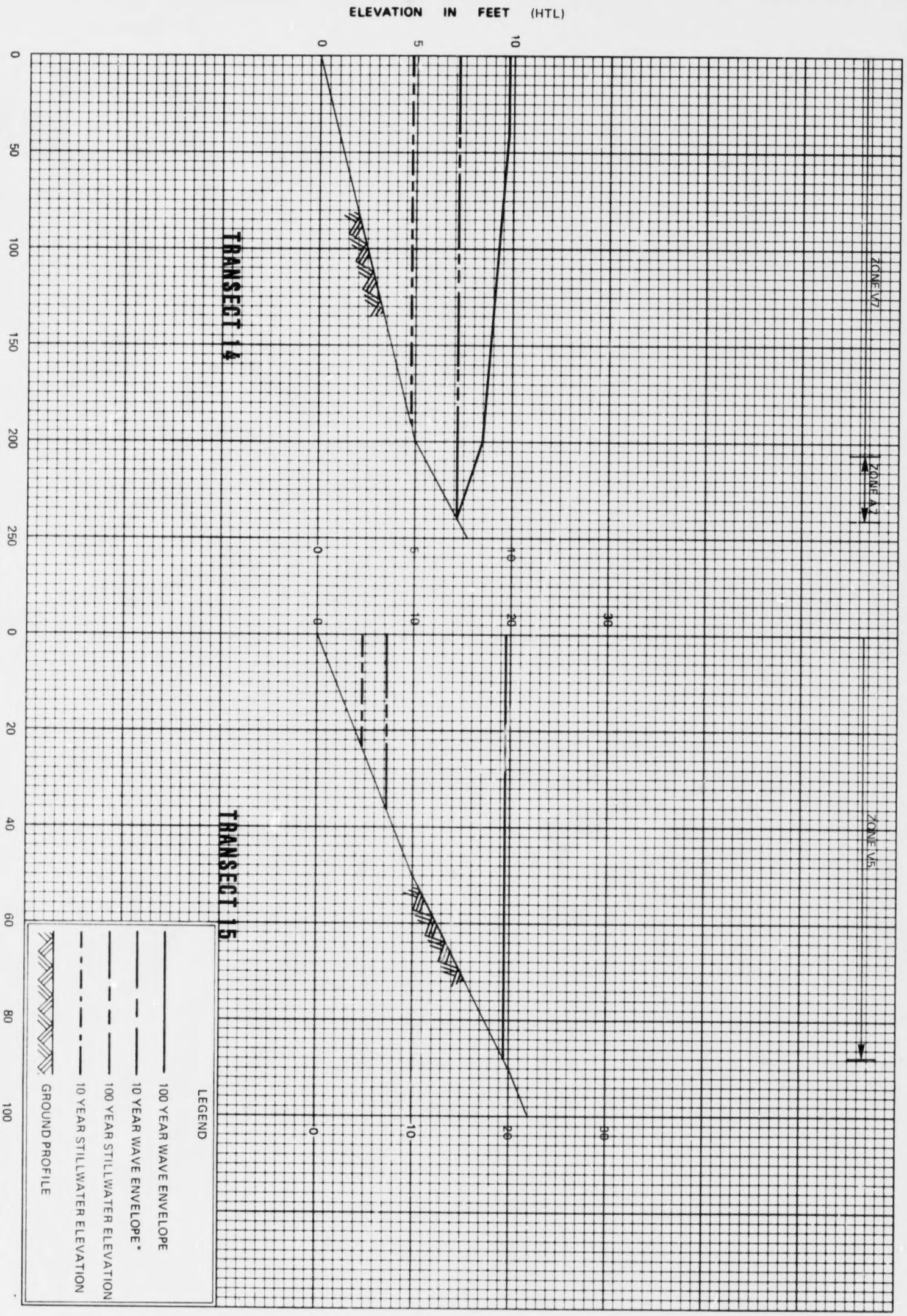
TRANSECTS 12 AND 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

06C

BEST COPY AVAILABLE



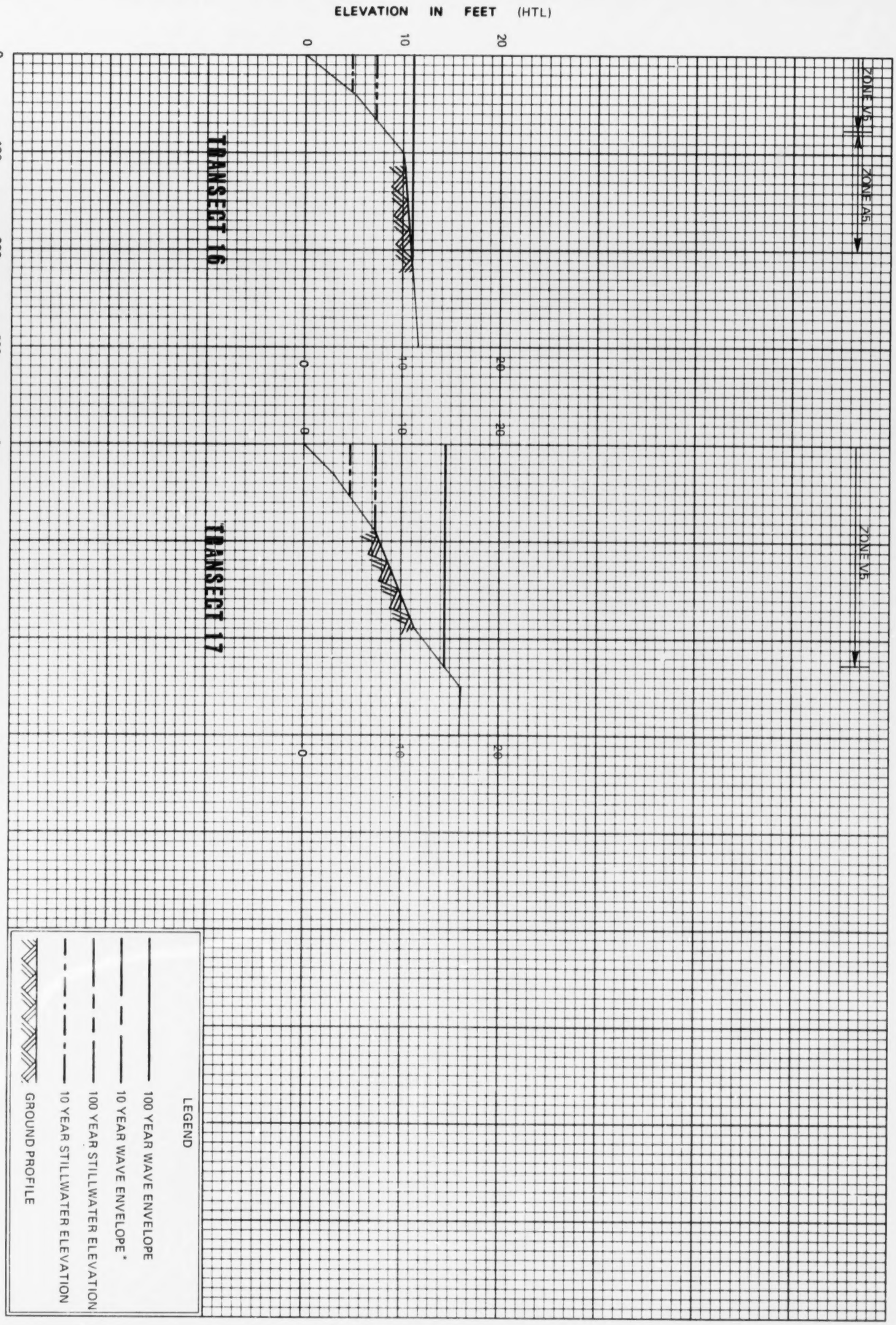
FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

COASTAL PROFILES

TRANSECTS 14 AND 15

07C



FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

COASTAL PROFILES

TRANSECTS 16 AND 17

28C

27

BEST COPY AVAILABLE

ZONE V7 | ZONE V6 | ZONE A5 | ZONE V5

ELEVATION IN FEET (HTL)

20
10
0

TRANSECT 18

TRANSECT 19

LEGEND

- 100 YEAR WAVE ENVELOPE
- 10 YEAR WAVE ENVELOPE *
- 100 YEAR STILLWATER ELEVATION
- 10 YEAR STILLWATER ELEVATION
- GROUND PROFILE

0 50 100 150 200 250 300 0 20 40 60 80 100

DISTANCE FROM EL. 0.0 FT (HTL) IN FEET

*10-YEAR WAVE ENVELOPE NOT COMPUTED

COASTAL PROFILES

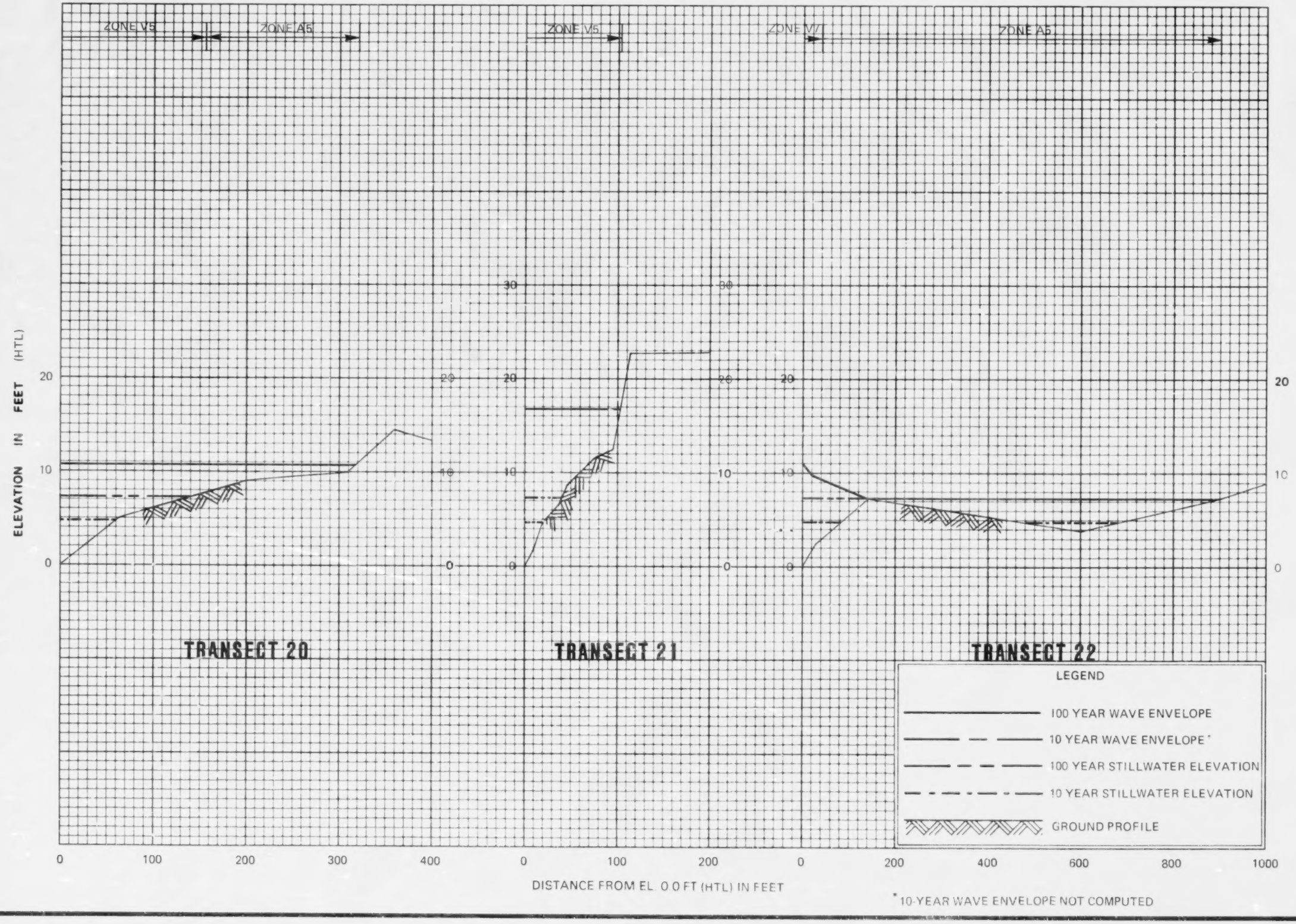
TRANSECTS 18 AND 19

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

09C

BEST COPY AVAILABLE



*10-YEAR WAVE ENVELOPE NOT COMPUTED

COASTAL PROFILES

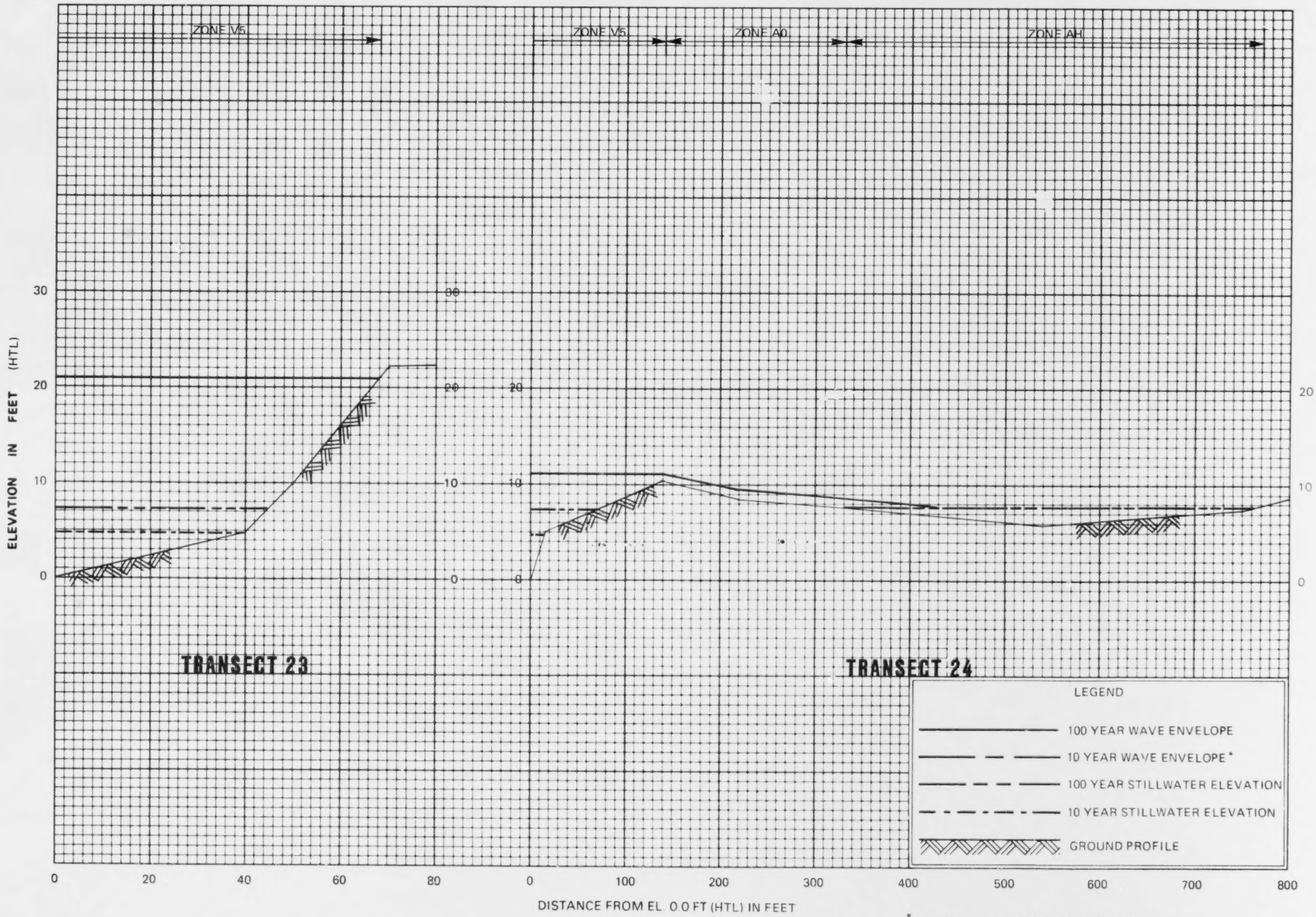
TRANSECTS 20,21,AND 22

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

10C

BEST COPY AVAILABLE



COASTAL PROFILES

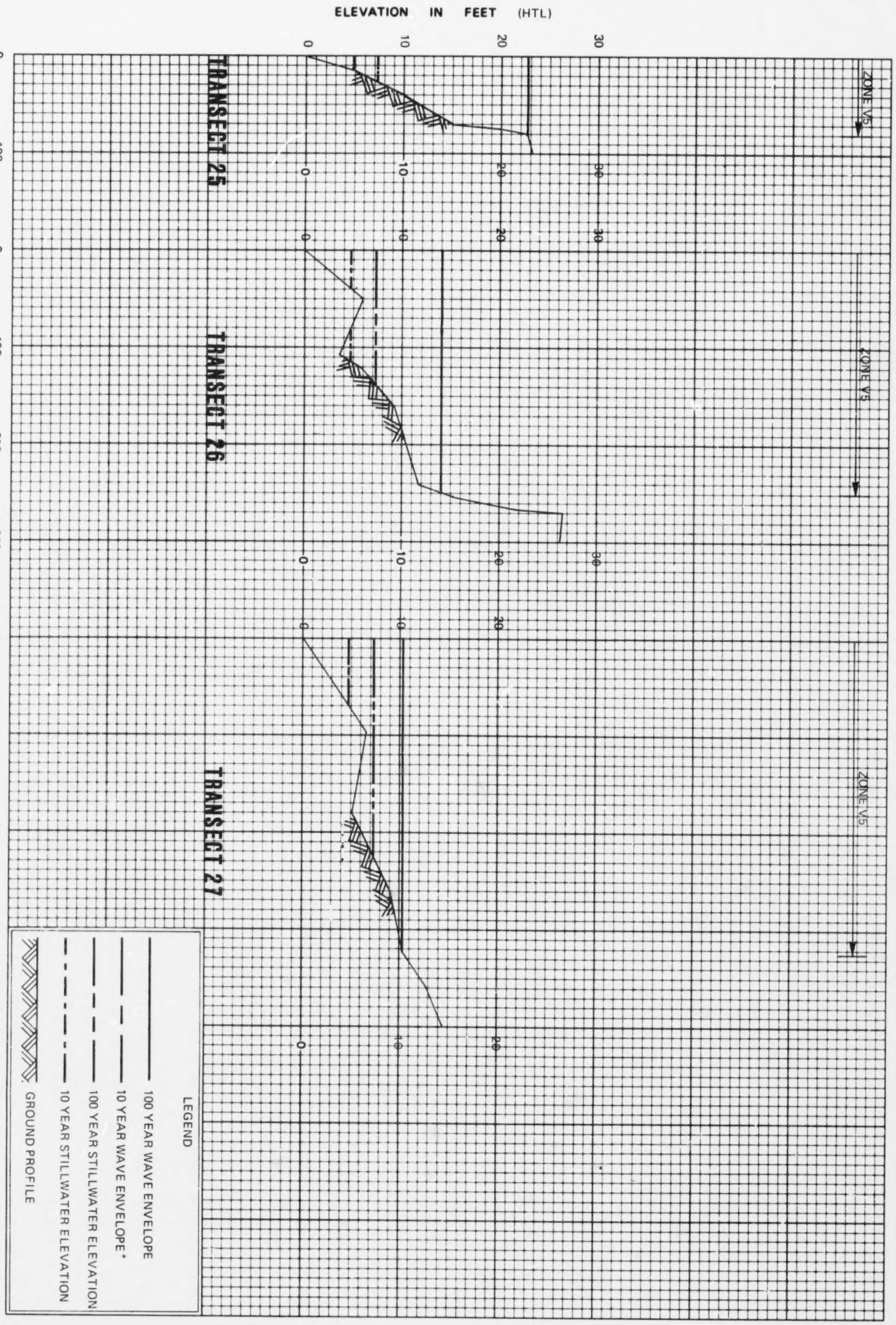
TRANSECTS 23 AND 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

11C

BEST COPY AVAILABLE



FEDERAL EMERGENCY MANAGEMENT AGENCY

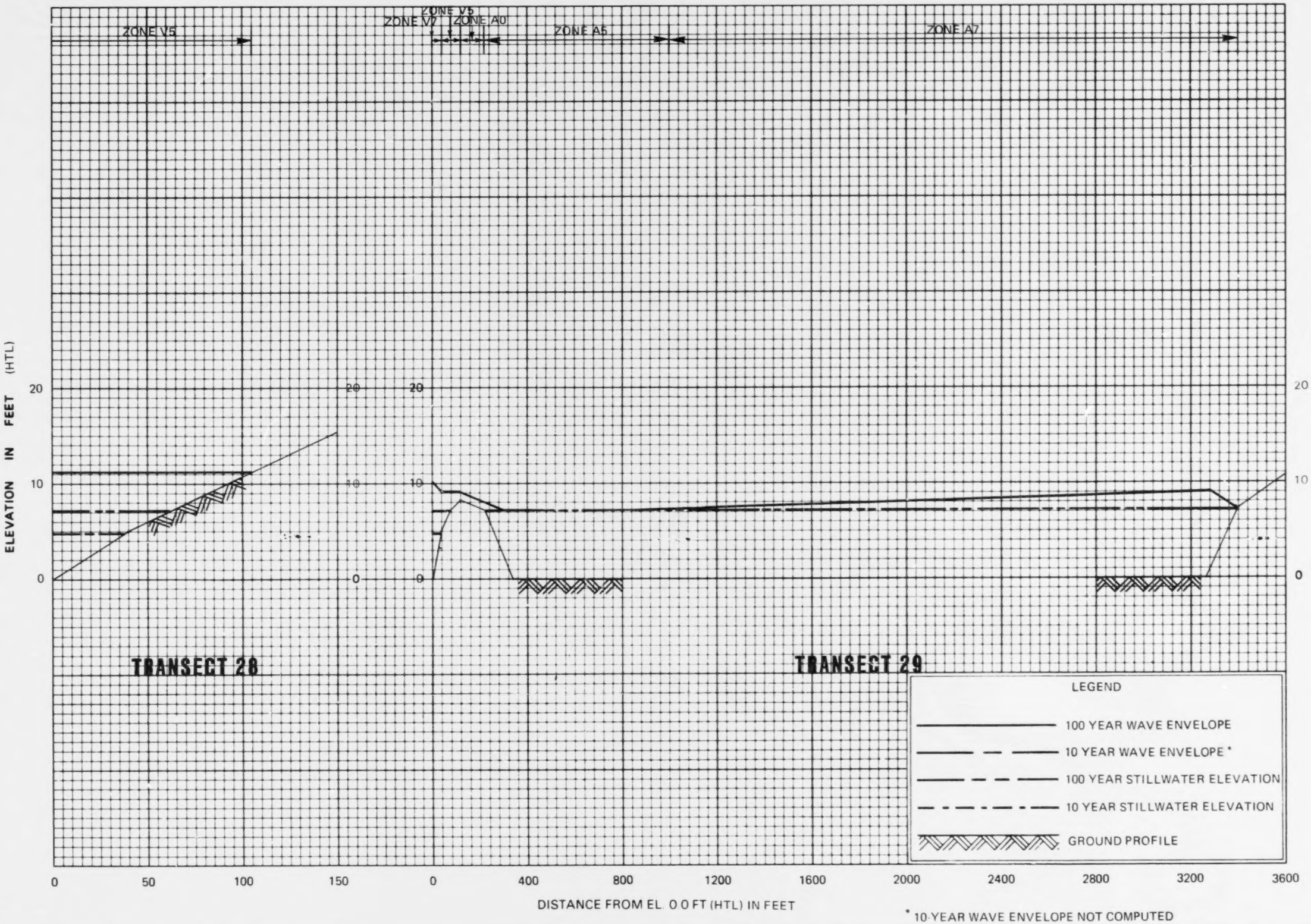
TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

12C

COASTAL PROFILES

TRANSECTS 25,26,AND 27

BEST COPY AVAILABLE



* 10-YEAR WAVE ENVELOPE NOT COMPUTED

COASTAL PROFILES

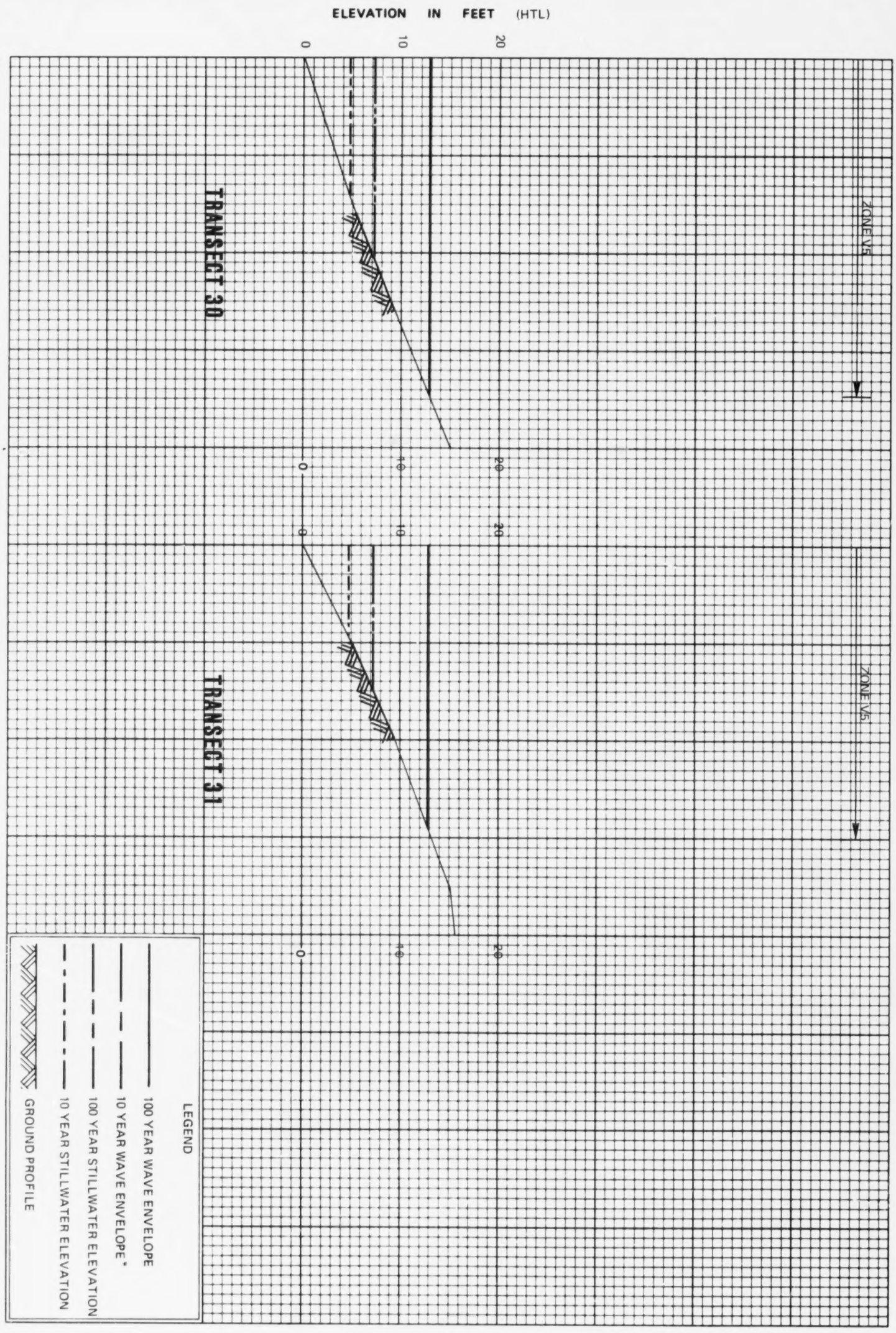
TRANSECTS 28 AND 29

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

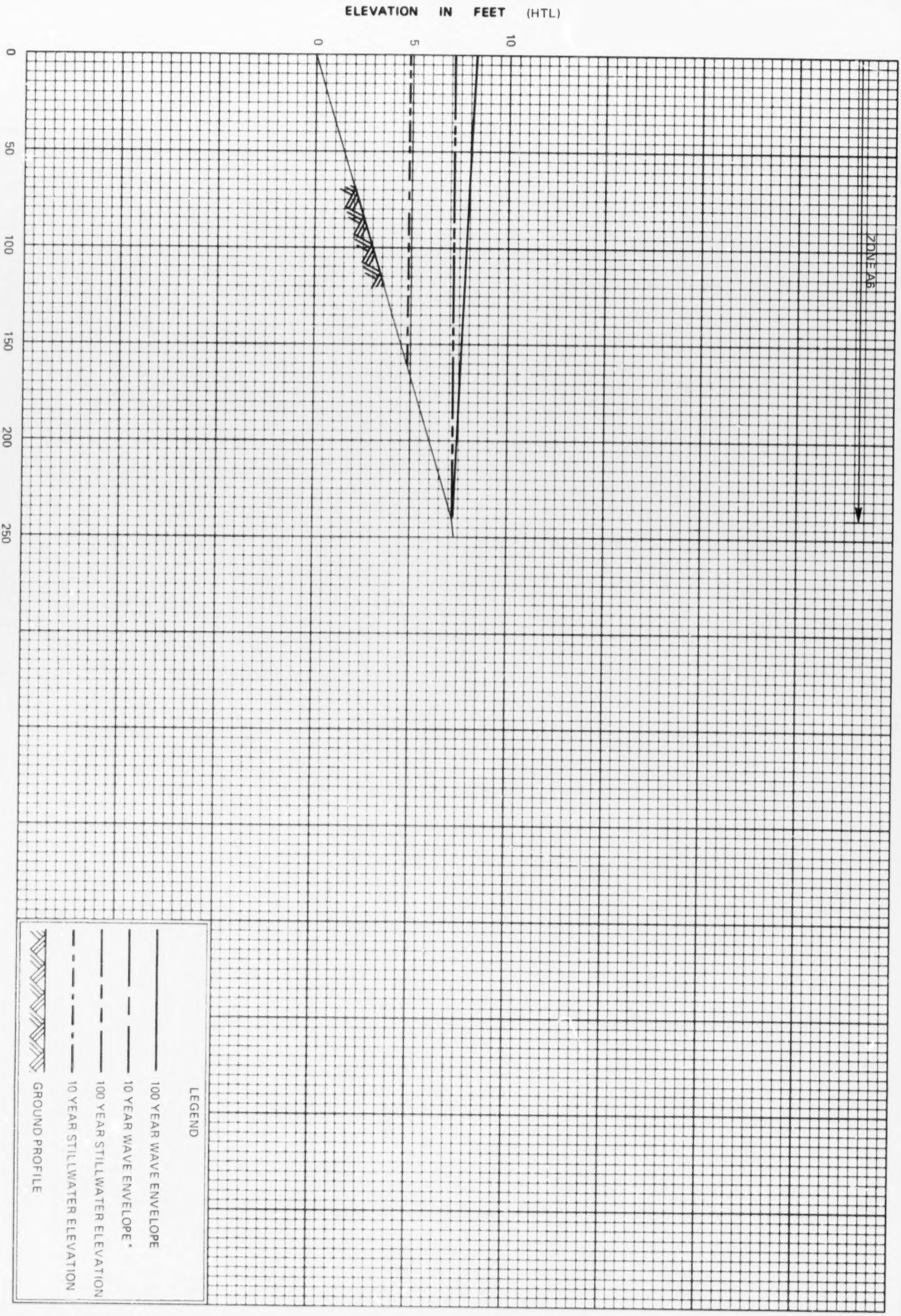
13C

BEST COPY AVAILABLE



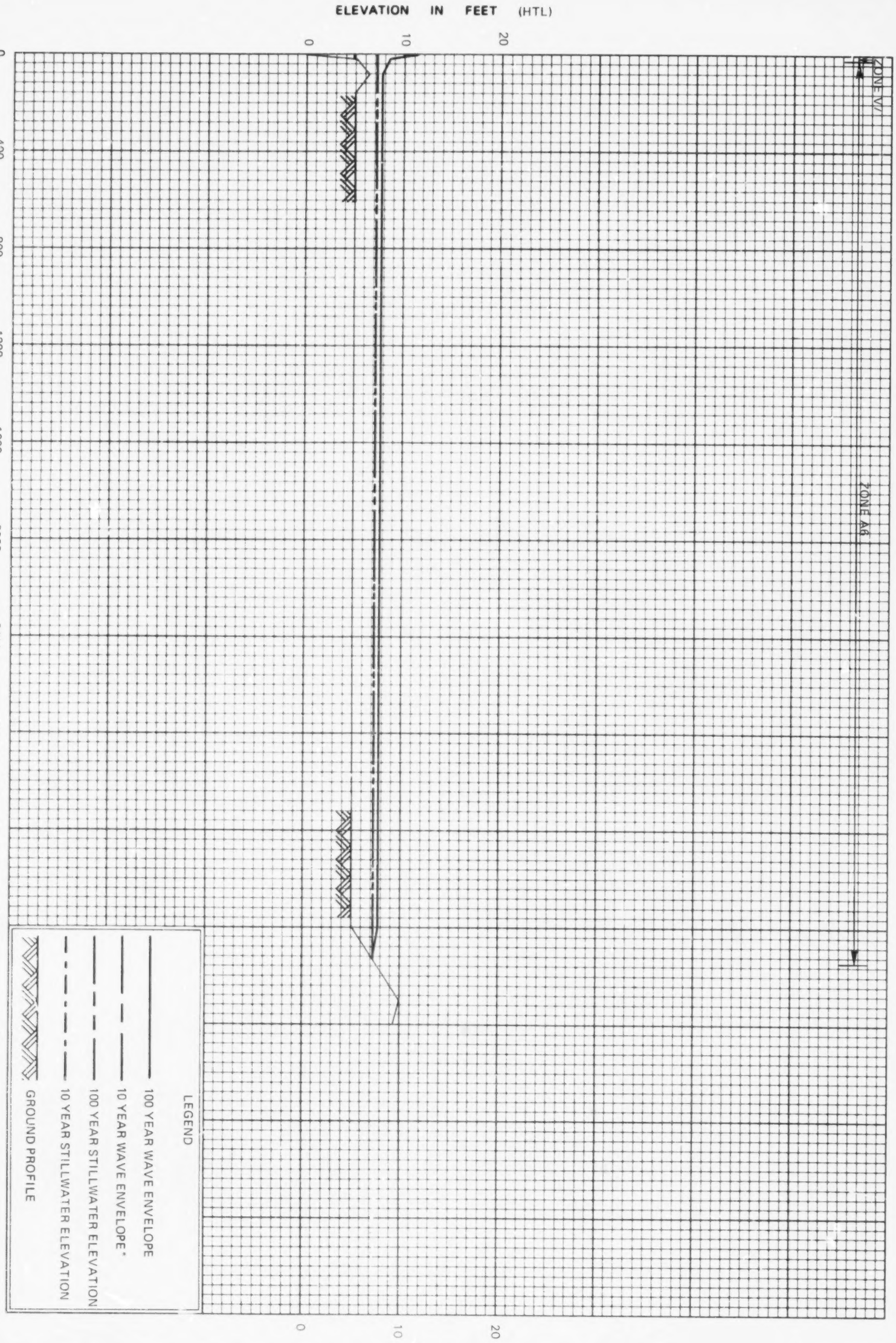
14C	FEDERAL EMERGENCY MANAGEMENT AGENCY **TOWN OF NANTUCKET, MA** (NANTUCKET CO.)	**COASTAL PROFILES** **TRANSECTS 30 AND 31**

BEST COPY AVAILABLE



15C	FEDERAL EMERGENCY MANAGEMENT AGENCY **TOWN OF NANTUCKET, MA** (NANTUCKET CO.)	**COASTAL PROFILES** **TRANSECT 32**

BEST COPY AVAILABLE



35

FEDERAL EMERGENCY MANAGEMENT AGENCY

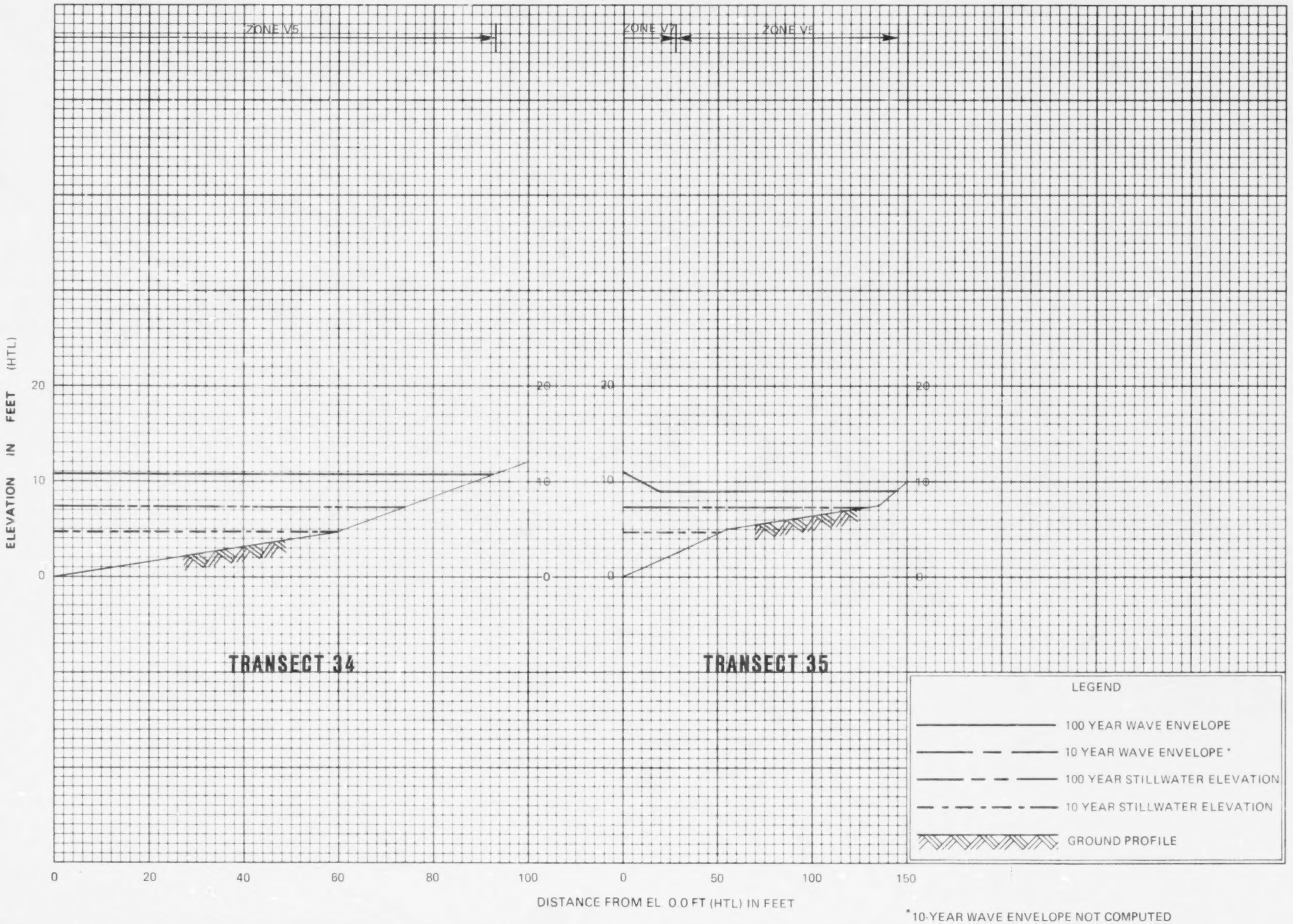
TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

16C

COASTAL PROFILES

TRANSECT 33

BEST COPY AVAILABLE



*10-YEAR WAVE ENVELOPE NOT COMPUTED

COASTAL PROFILES

TRANSECTS 34 AND 35

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

17C

BEST COPY AVAILABLE

ZONE V5

ZONE V5

ZONE V5

ELEVATION IN FEET (HTL)

20

10

0

20

10

0

20

10

0

20

10

0

TRANSECT 36

TRANSECT 37

TRANSECT 38

LEGEND

100 YEAR WAVE ENVELOPE

10 YEAR WAVE ENVELOPE *

100 YEAR STILLWATER ELEVATION

10 YEAR STILLWATER ELEVATION

GROUND PROFILE

0 20 40 60 80 0 20 40 60 80 0 20 40 60

DISTANCE FROM EL 0.0 FT (HTL) IN FEET

* 10-YEAR WAVE ENVELOPE NOT COMPUTED

COASTAL PROFILES

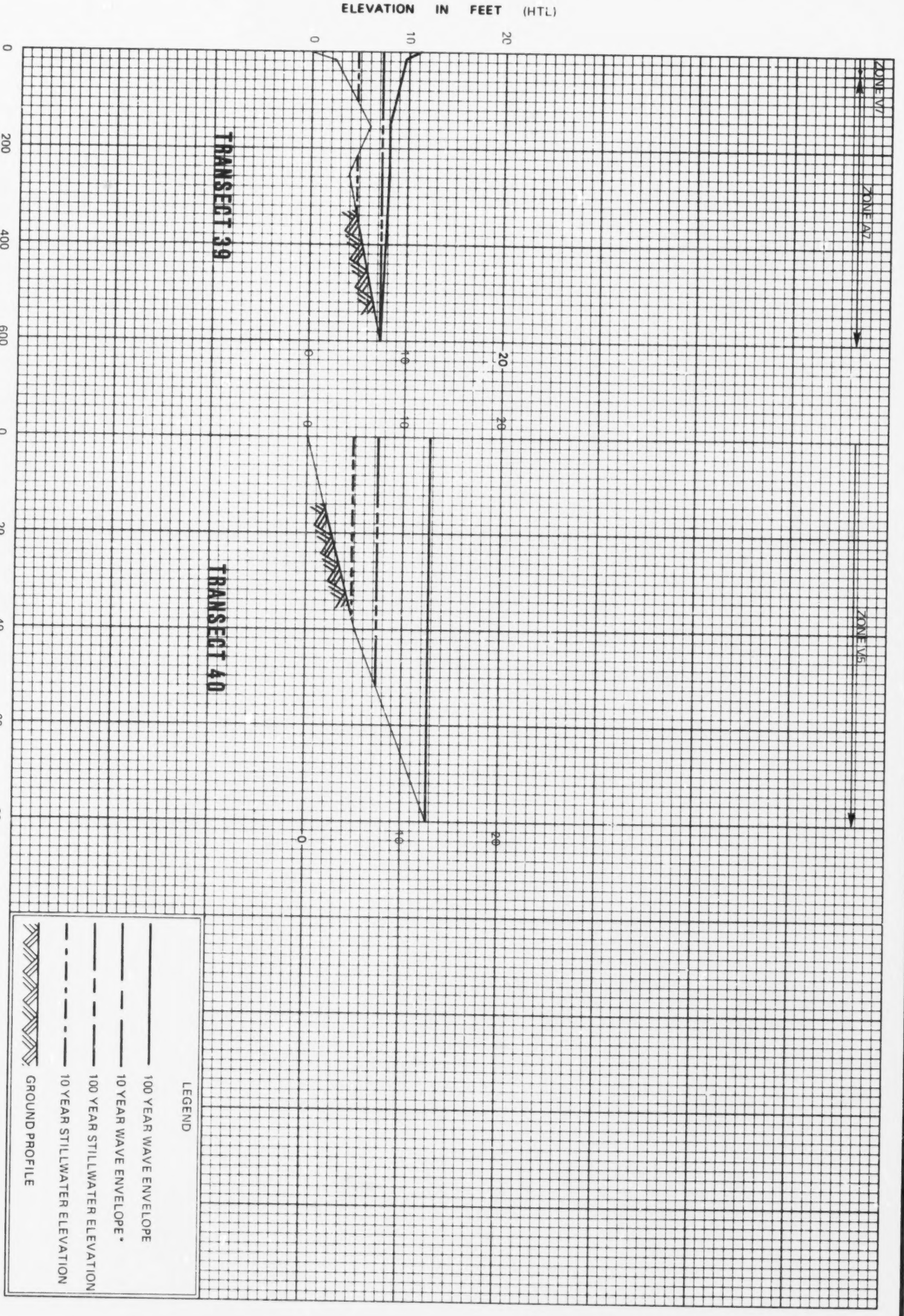
TRANSECTS 36,37,AND 38

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

18C

BEST COPY AVAILABLE



FEDERAL EMERGENCY MANAGEMENT AGENCY

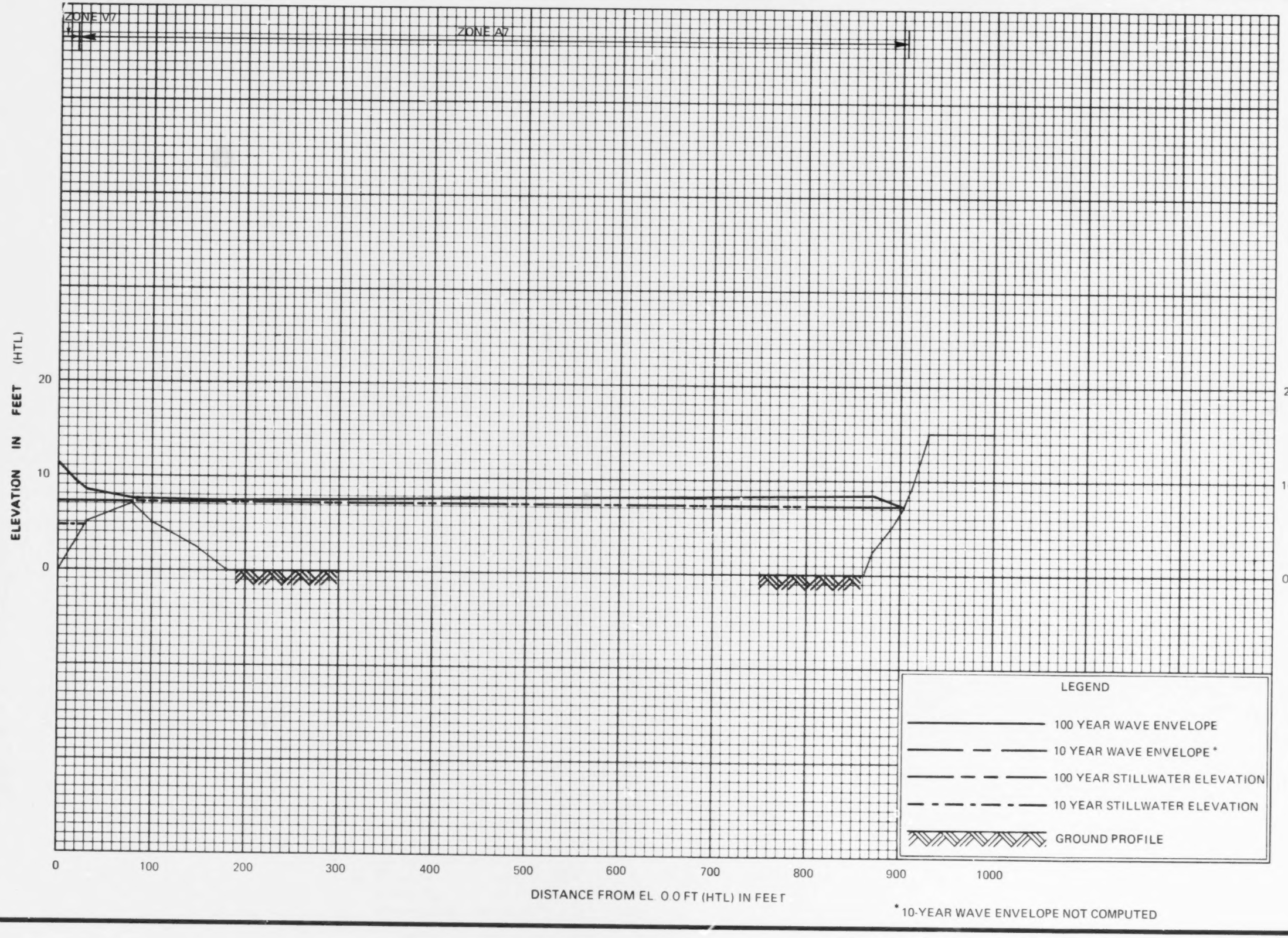
TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

COASTAL PROFILES

TRANSECTS 39 AND 40

19C

BEST COPY AVAILABLE



COASTAL PROFILES

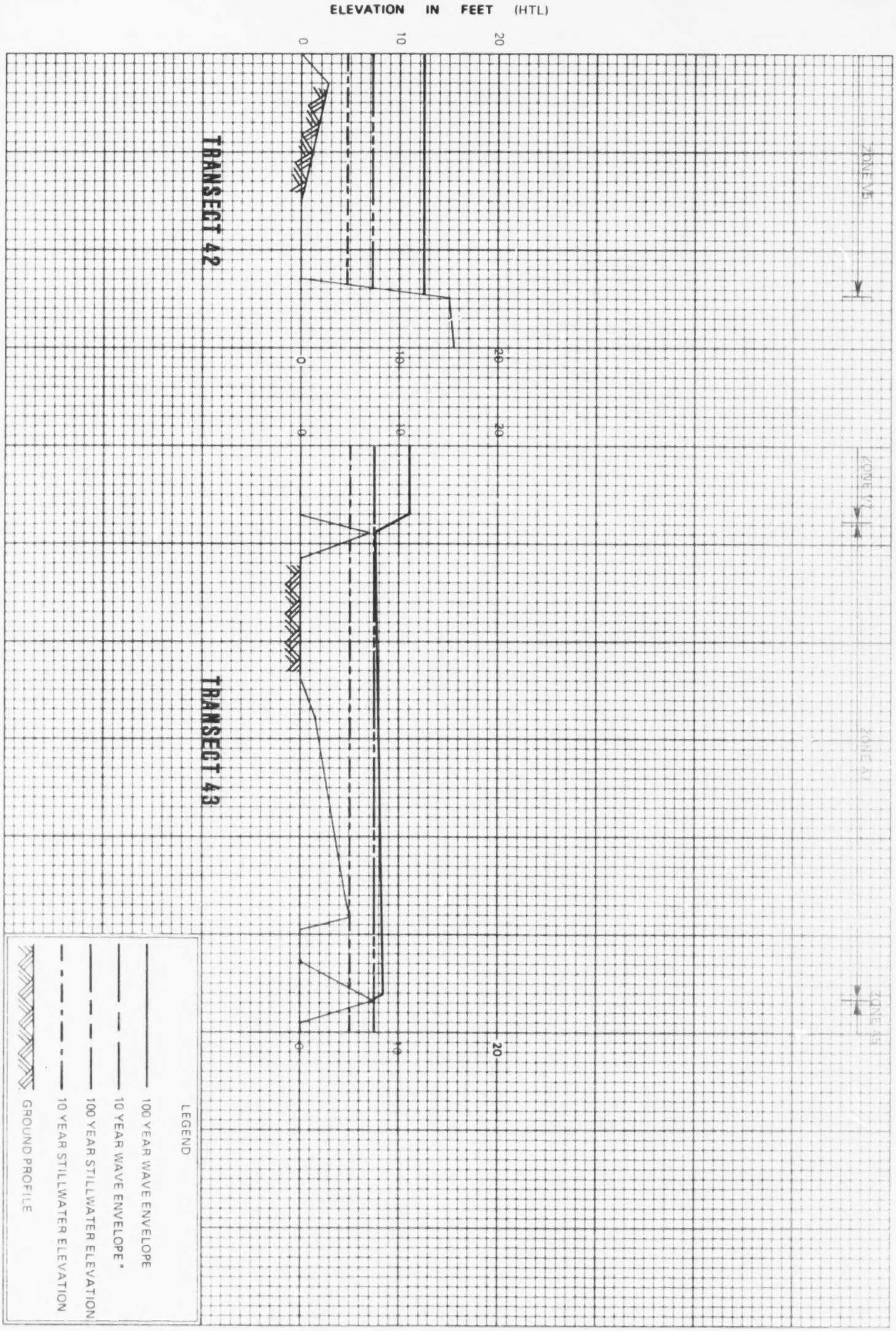
TRANSECT 41

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

20C

BEST COPY AVAILABLE



21C	FEDERAL EMERGENCY MANAGEMENT AGENCY **TOWN OF NANTUCKET, MA** (NANTUCKET CO.)	**COASTAL PROFILES** **TRANSECTS 42 AND 43**

BEST COPY AVAILABLE

ELEVATION IN FEET (HTL)

0 10 20

ZONE A6

TRANSECT 44

0 10 20

ZONE A6

TRANSECT 45

0 10 20

LEGEND

- 100 YEAR WAVE ENVELOPE
- 10 YEAR WAVE ENVELOPE*
- 100 YEAR STILLWATER ELEVATION
- 10 YEAR STILLWATER ELEVATION
- GROUND PROFILE

0 200 400 600 800 0 200 400 600 800 1000 1200

DISTANCE FROM EL. 0.0 FT (HTL) IN FEET

*10 YEAR WAVE ENVELOPE NOT COMPUTED

FEDERAL EMERGENCY MANAGEMENT AGENCY

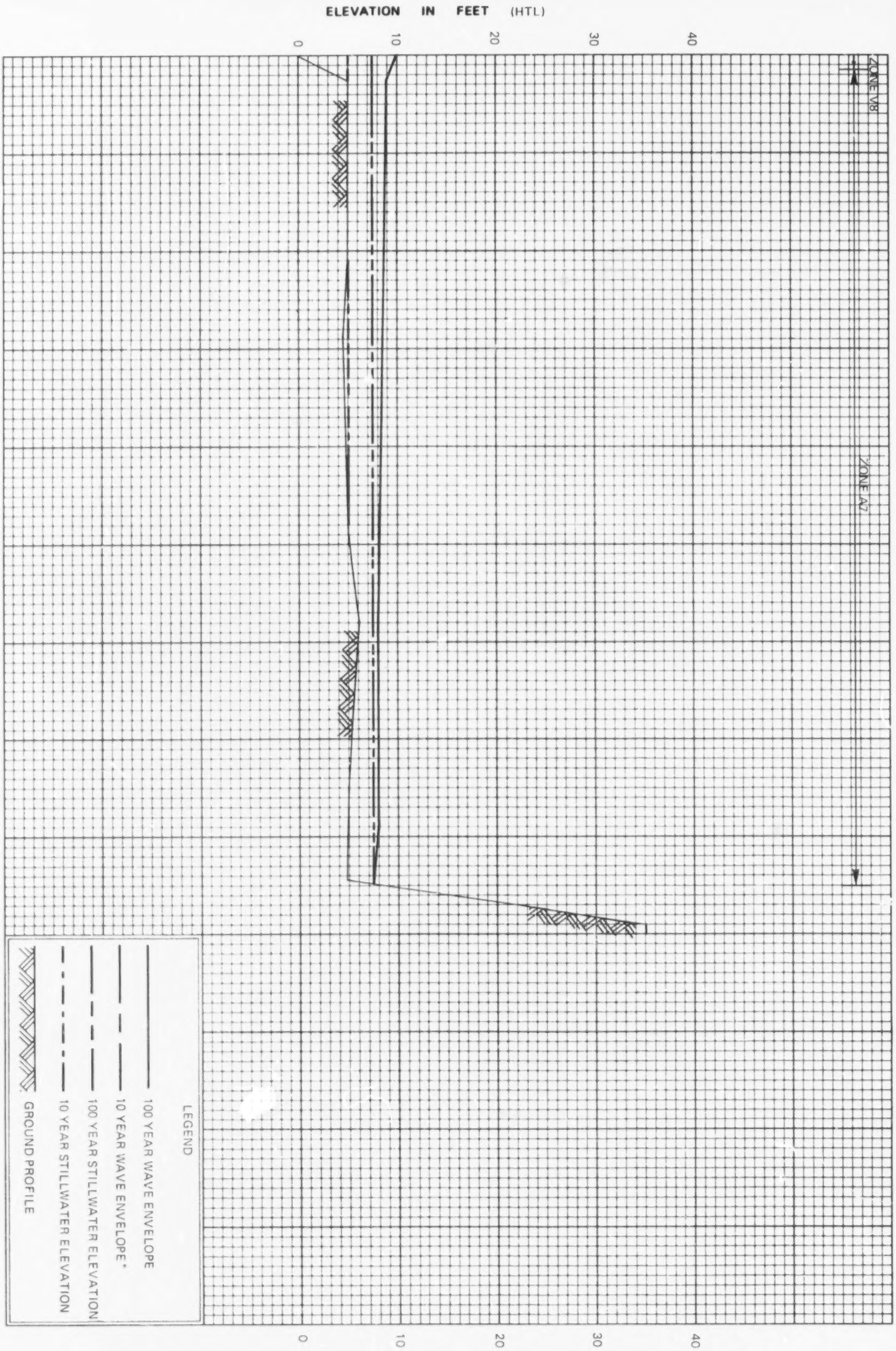
TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

22C

COASTAL PROFILES

TRANSECTS 44 AND 45

BEST COPY AVAILABLE



FEDERAL EMERGENCY MANAGEMENT AGENCY

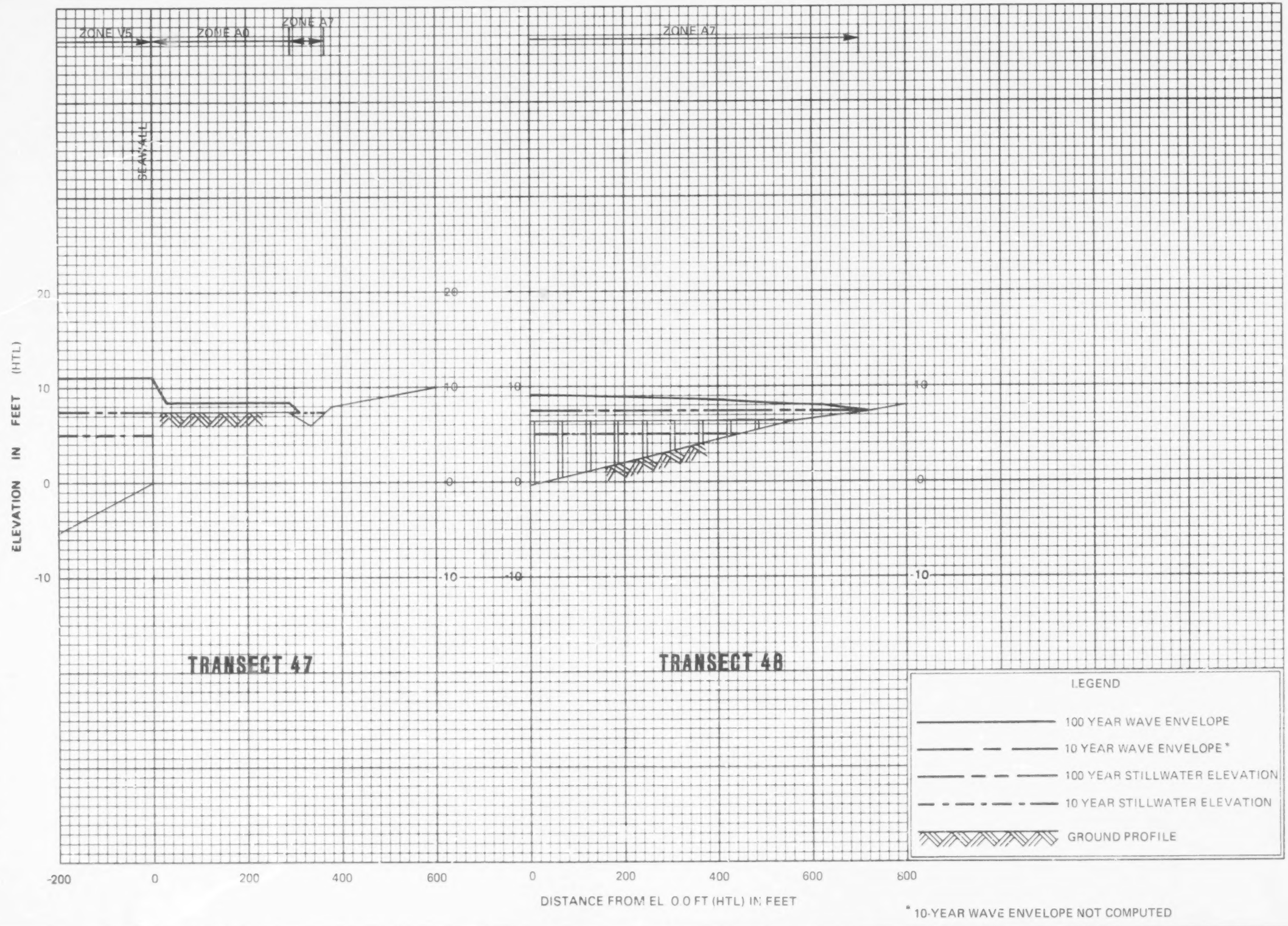
TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

COASTAL PROFILES

TRANSECT 46

23C

BEST COPY AVAILABLE



* 10-YEAR WAVE ENVELOPE NOT COMPUTED

COASTAL PROFILES

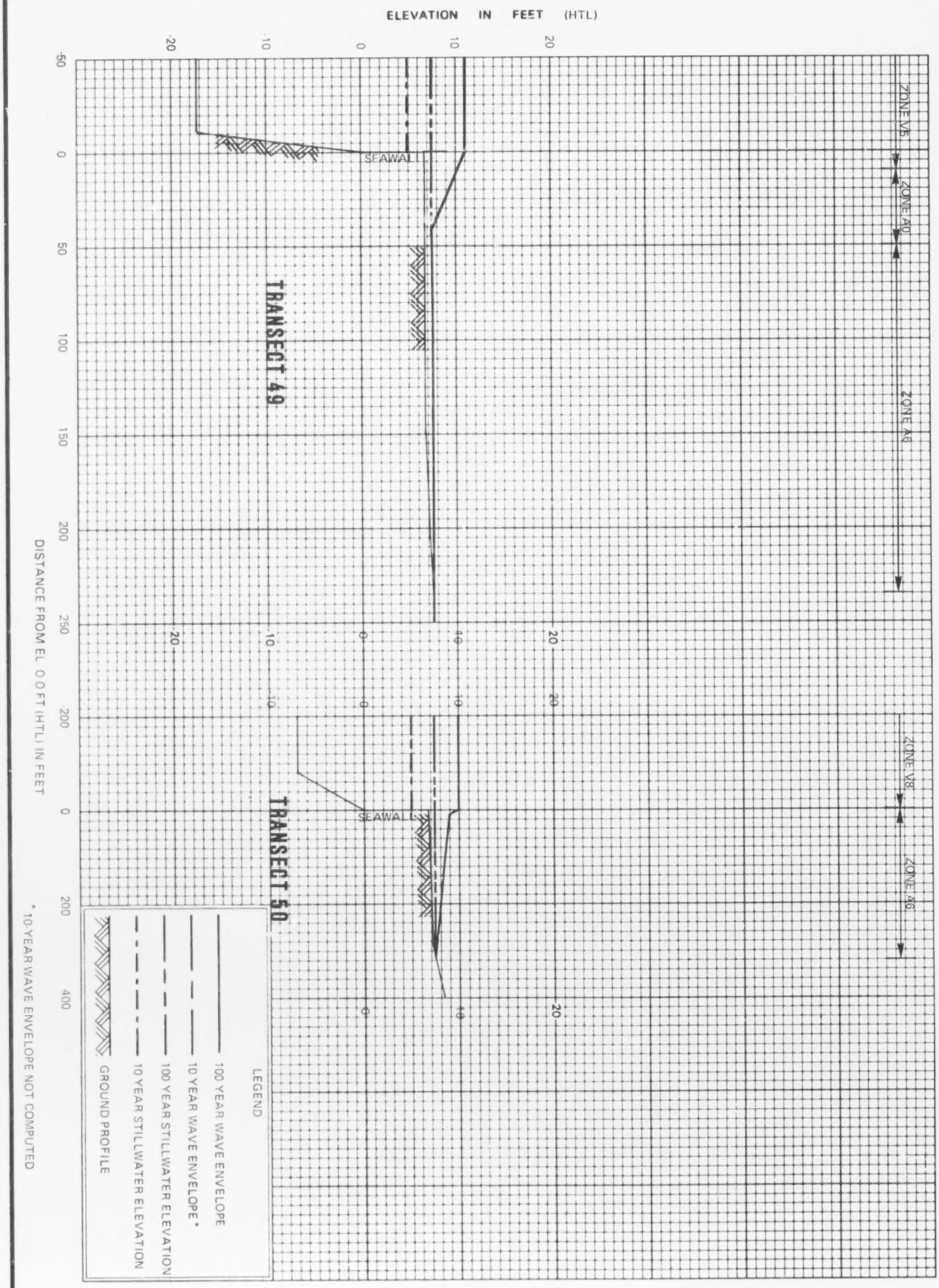
TRANSECTS 47 AND 48

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

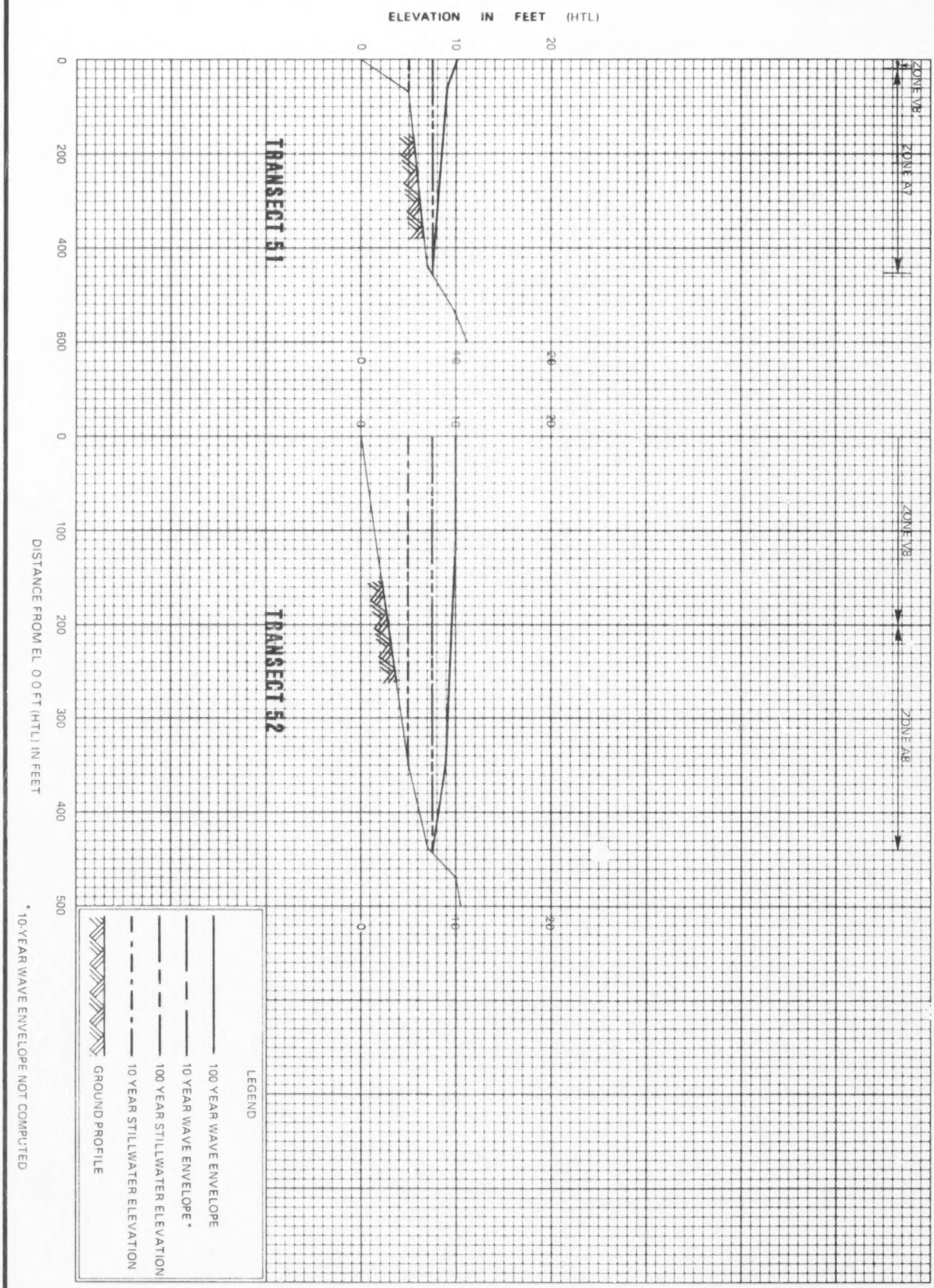
24C

BEST COPY AVAILABLE

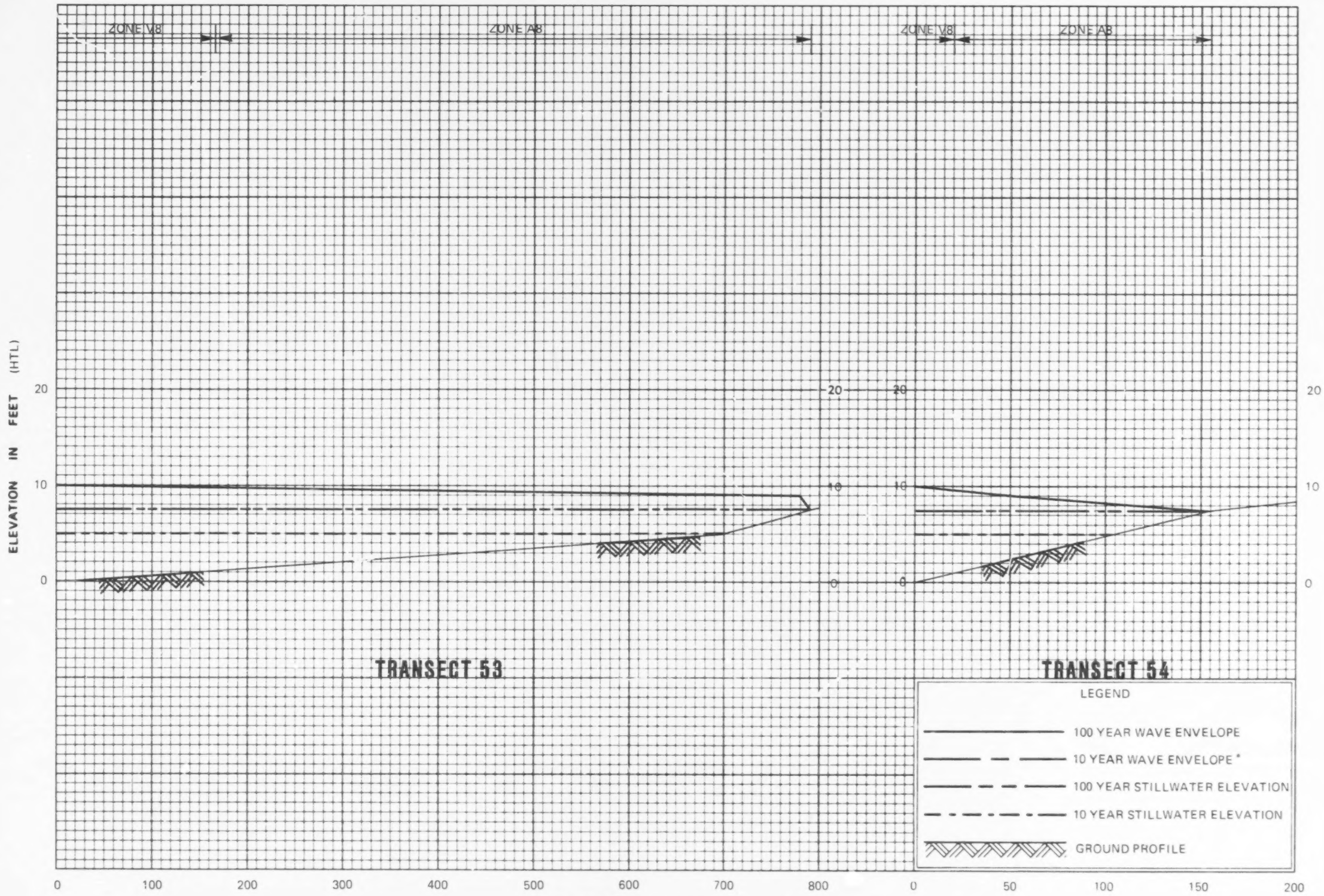


25C	FEDERAL EMERGENCY MANAGEMENT AGENCY **TOWN OF NANTUCKET, MA** (NANTUCKET CO.)	**COASTAL PROFILES** **TRANSECTS 49 AND 50**

BEST COPY AVAILABLE



26C	FEDERAL EMERGENCY MANAGEMENT AGENCY **TOWN OF NANTUCKET, MA** (NANTUCKET CO.)	**COASTAL PROFILES** **TRANSECTS 51 AND 52**



*10-YEAR WAVE ENVELOPE NOT COMPUTED

COASTAL PROFILES

TRANSECTS 53 AND 54

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

27C

BEST COPY AVAILABLE

ELEVATION IN FEET (HTL)

0 10 20

0 50 100 150 200 250 300

DISTANCE FROM EL 0.0 FT (HTL) IN FEET

ZONE VB

ZONE A7

LEGEND

100 YEAR WAVE ENVELOPE

10 YEAR WAVE ENVELOPE*

100 YEAR STILLWATER ELEVATION

10 YEAR STILLWATER ELEVATION

GROUND PROFILE

*10 YEAR WAVE ENVELOPE NOT COMPUTED

FEDERAL EMERGENCY MANAGEMENT AGENCY

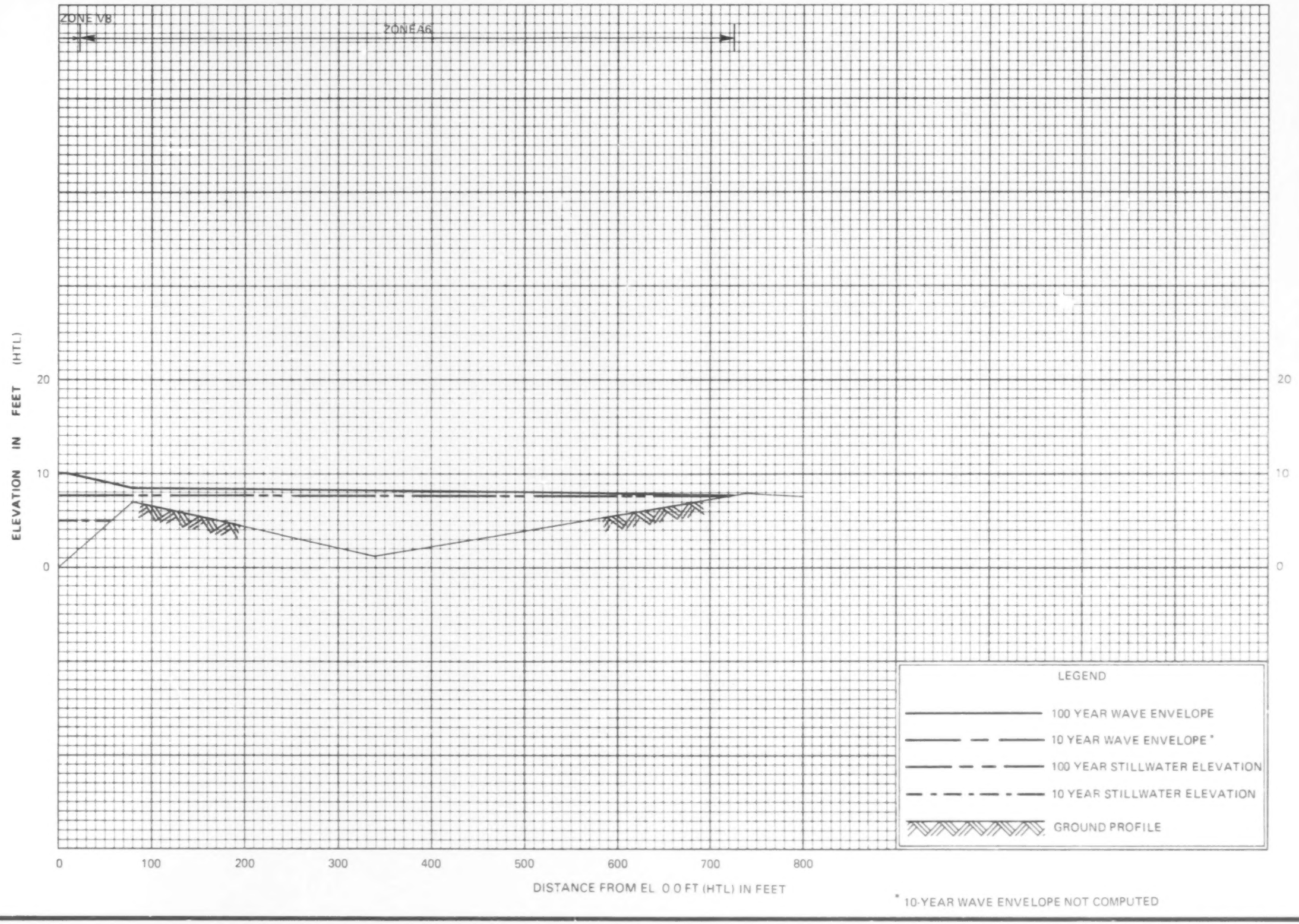
TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

COASTAL PROFILES

TRANSECT 55

28C

BEST COPY AVAILABLE



* 10-YEAR WAVE ENVELOPE NOT COMPUTED

COASTAL PROFILES

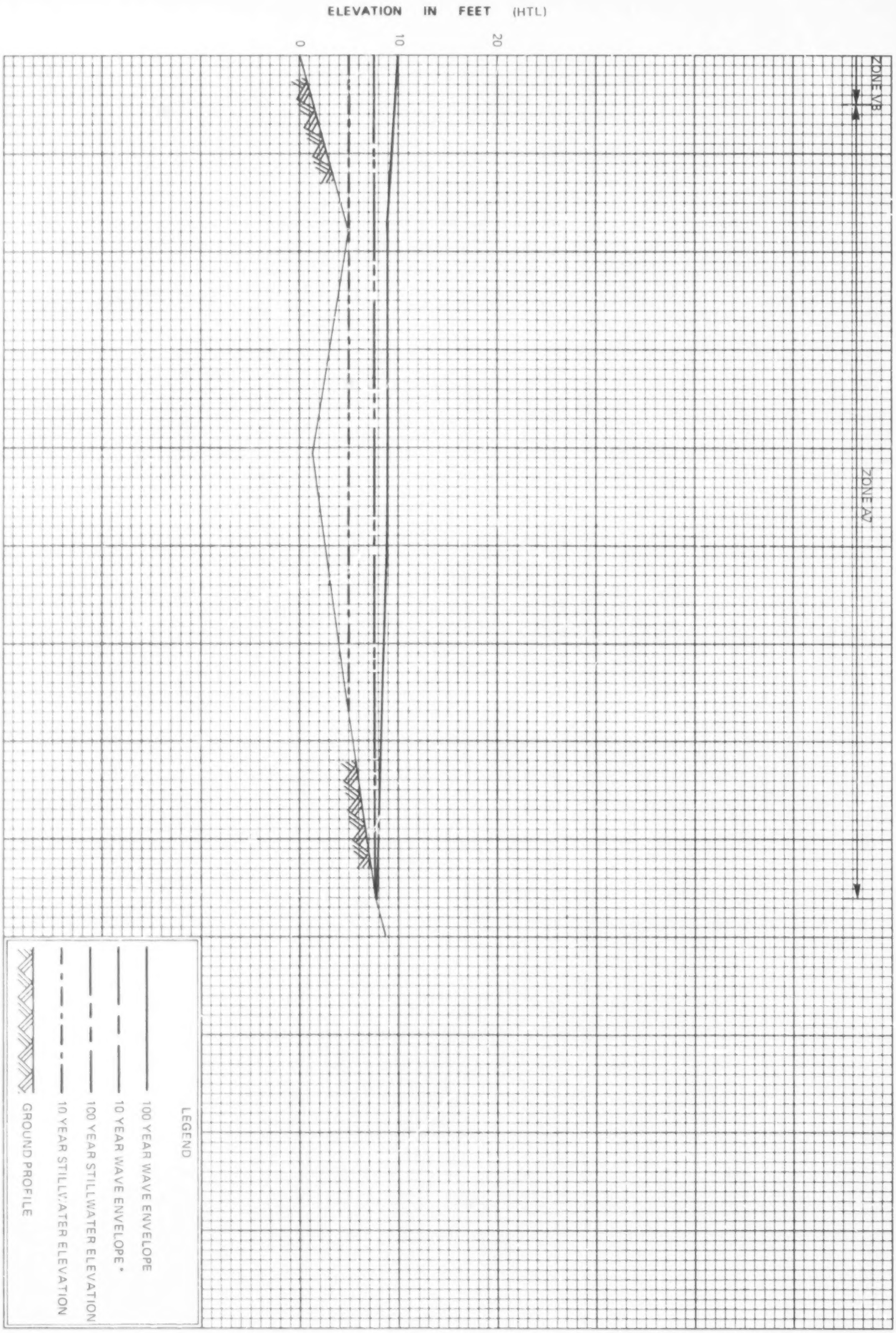
TRANSECT 56

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

29C

BEST COPY AVAILABLE



30C

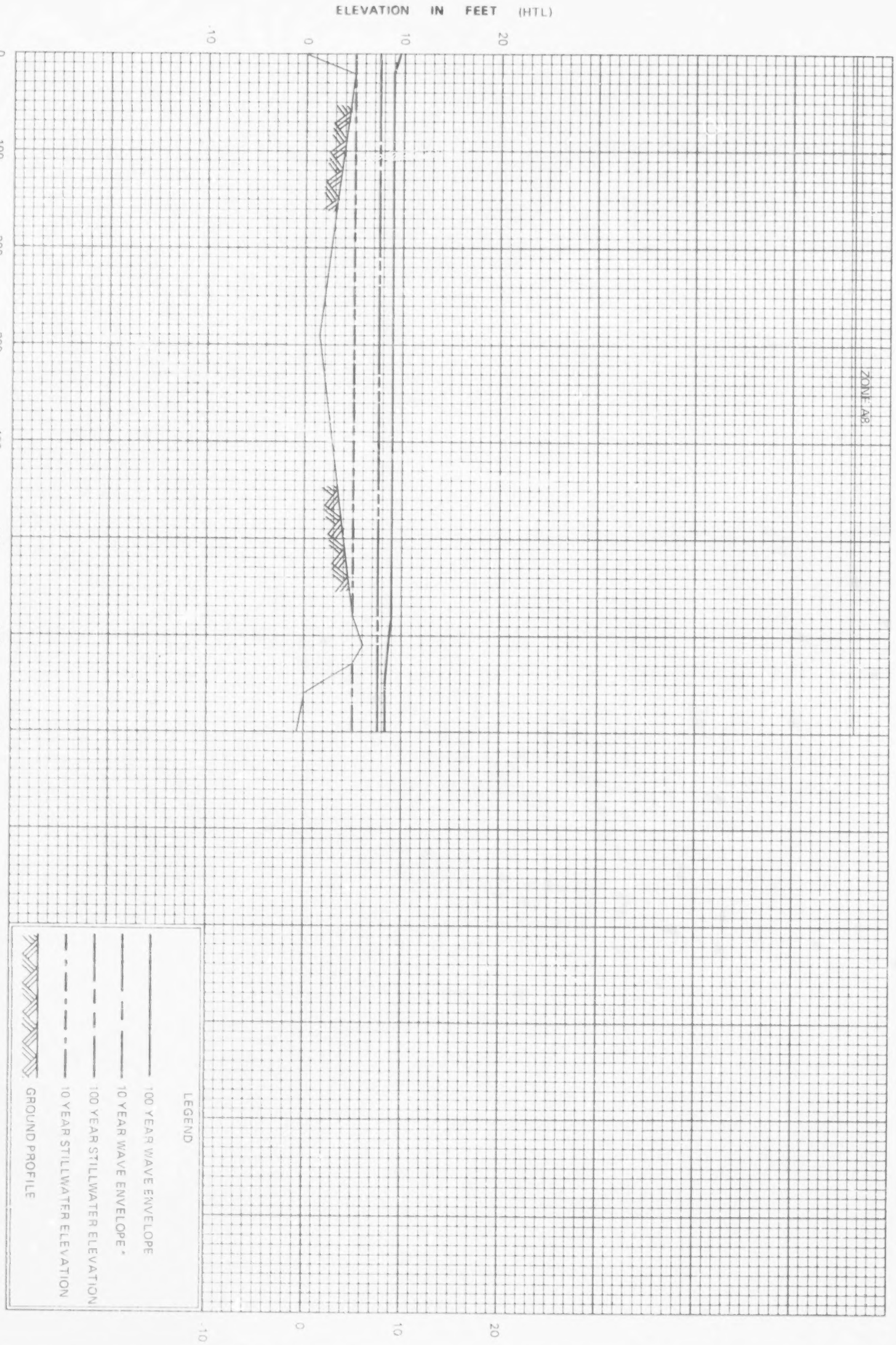
FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

COASTAL PROFILES

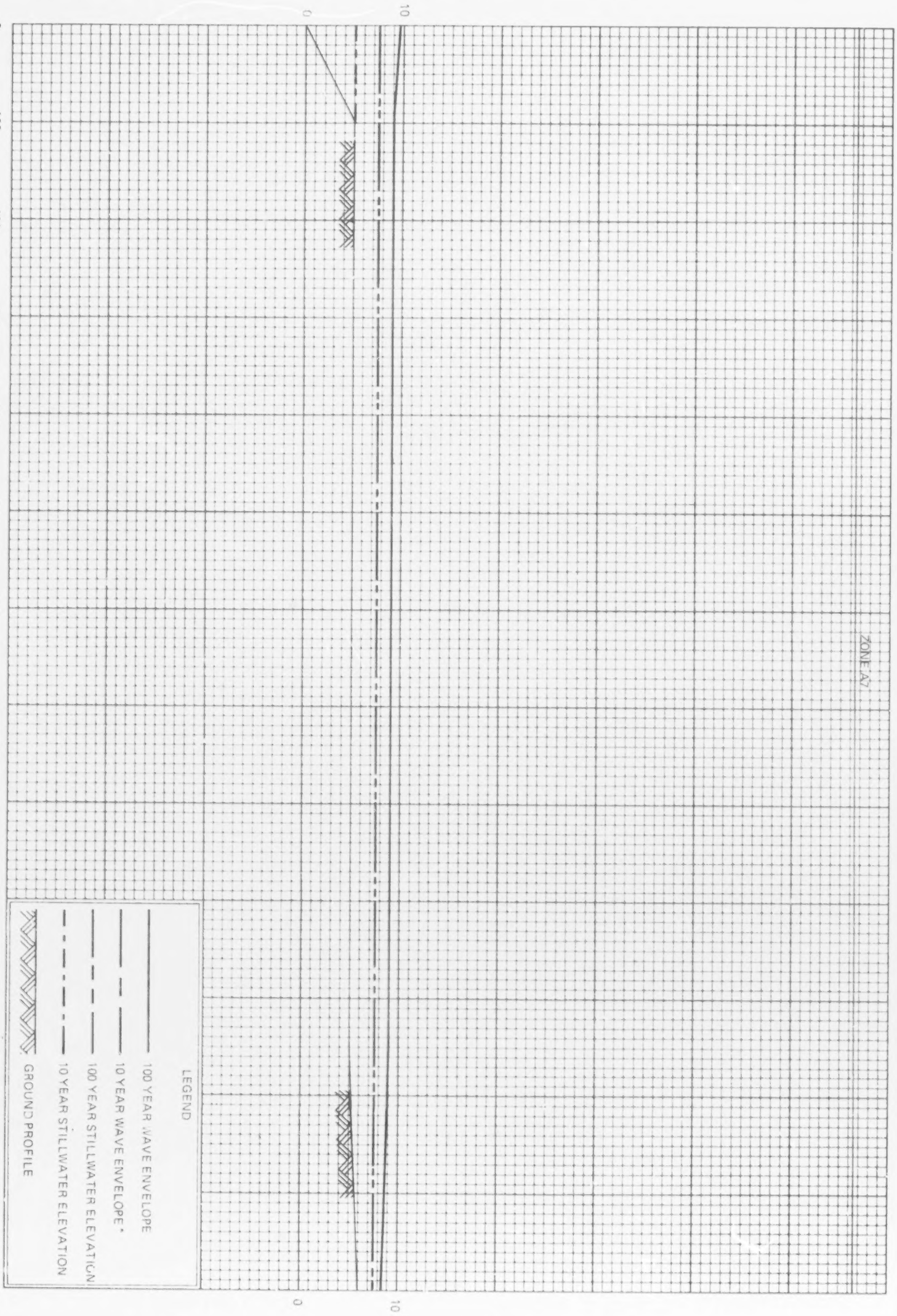
TRANSECT 57

BEST COPY AVAILABLE



31C	FEDERAL EMERGENCY MANAGEMENT AGENCY **TOWN OF NANTUCKET, MA** (NANTUCKET CO.)	**COASTAL PROFILES** **TRANSECT 58**

ELEVATION IN FEET (HTL)



DISTANCE FROM EL 0.0 FT (HTL) IN FEET

*10-YEAR WAVE ENVELOPE NOT COMPUTED

32C	FEDERAL EMERGENCY MANAGEMENT AGENCY **TOWN OF NANTUCKET, MA** (NANTUCKET CO.)	**COASTAL PROFILES** **TRANSECT 59**

BEST COPY AVAILABLE

ELEVATION IN FEET (HTL)

*10 YEAR WAVE ENVELOPE NOT COMPUTED

S2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NANTUCKET, MA
(NANTUCKET CO.)

COASTAL PROFILES

TRANSECT 59

33C

BEST COPY AVAILABLE